BRAIN.

JULY, 1885.

Original Articles.

ON THE CORPUS CALLOSUM IN THE EMBRYO.

BY D. J. HAMILTON, M.B., F.R.S.E.,

Professor of Pathological Anatomy, University of Aberdeen.

In a paper which I communicated to the Royal Society on February 23, 1884, I detailed certain facts and figured certain appearances in the *adult* brain which led me to believe that the Corpus Callosum is not an interhemispherical commissure, as is generally supposed, but in reality the decussation of a great part of those fibres derived from the cortex which do not decussate at some point further down. The facts were mainly these, that when the brain is prepared in the method I employ (see 'BRAIN,' July 1883) the fibres of the corpus callosum, instead of stretching across from side to side between the hemispheres, are found to come from the cortex of one side to pass over to the opposite side, and having gained this, to turn down into the inner and outer capsules. I endeavoured to show that the bulk of the fibres which enter the inner capsule, both in its anterior and posterior segments, is composed of such crossed callosal bundles, while the motor and other fibrès which come chiefly from the cortex of the same side, which do not pass over in the corpus callosum, and which decussate further down, constitute but a small part of the entire inner capsule.

The outer capsule, I demonstrated, is composed of two layers —an external and an internal. The external derives its fibres

from the operculum and edge of the Sylvian fossa behind this, while the inner is made up mainly, if not entirely, of crossed callosal fibres, which have come from the opposite side, and turned downwards.

As regards the destination of these crossed callosal fibres which have thus passed downwards into the two capsules, I pointed out that they chiefly terminate in the thalamus opticus. A few of them end in the caudate nucleus, while a considerable number, in all probability, find their way further downwards to end in the pons Varolii or other masses of grey matter below the basal ganglia. The majority, if not all the motor fibres do not pass through the corpus callosum; they belong to a different system, and, partly, at least, are continued down through the pyramids to the spinal cord as usually described.

There are therefore two main sets of fibres entering the inner capsule from the cerebral cortex; the one set comes from the opposite hemisphere, decussates in the corpus callosum, and subsequently enters the capsule: the other set, much the smaller of the two, passes into it from the cortex of the same side, and decussates somewhere lower down, chiefly in the medulla oblongata.

The facts supporting these views were mainly derived from the analysis of the nerve tracts in the *adult* human brain, and since then I have confirmed them, over and over again, in numerous observations. I find, moreover, the same appearances in all animals which I have examined, in which an undoubted corpus callosum is present. So far as I have gone, these comprise the ape, monkey, horse, sheep, dog, cat, and pig.

For the purpose of confirming or refuting the foregoing views, several methods of inquiry naturally suggest themselves, and among those which I have employed, and am at present employing, are the study of the corpus callosum in the embryo, the examination of it in destructive lesions in the human cortex, and experimental research in the lower animals. It is with the first of these—the corpus callosum in the embryo—that the present communication is chiefly concerned. The brains which I have employed in this present research, so far as it has gone, have been derived from the embryos of various

animals, and from the human fœtus. The latter, as is well known, has yielded in the hands of Flechsig the most brilliant results; and although my observations in some respects lie in a different path from those of that observer, yet I have also found that the human fœtal brain is excellently well suited for such investigations. The great difficulty, however, lies in getting the materials sufficiently fresh, for it will be found by those working at the subject, that unless perfectly fresh, the embryonic brain-substance loses that consistence which is necessary to hold its parts together. The embryos of mammals are also of course extremely useful in such an investigation, and as the majority of those slaughtered for food purposes can be obtained in various stages of fœtal life, I have employed these largely in conducting the present inquiry. I have examined the fœtal human brain at almost all ages, but that age which I would specially recommend as being most suited to demonstrate the connections of the corpus callosum, is *from the end of the third to the fourth month.* It is difficult to say, of course, in the human subject what the exact age of a fœtus may be, and hence Flechsig has fallen back upon length as a surer basis to reckon by. Fœtuses, however, differ so much in length at the same period of intra-uterine existence, that even this is to a certain extent misleading, and hence perhaps the various discrepancies in Flechsig's account of the period of medullation of the various nerve-fibre tracts.

The chief advantage of studying the corpus callosum in the embryo, I have found, lies in the fact, that its fibres are developed long before those which enter the inner capsule directly from the cortex of the same side. Hence those fibres which are callosal can be clearly traced in the embryo, apart from others with which they become associated and intermingled in the adult. It is, however, only at a certain period, the above mentioned, that this can be satisfactorily accomplished. Previous to this, the fibres are too rudimentary to afford good results, and, afterwards, the direct cortical tracts and the "association system" of fibres become so highly developed that the callosal bundles are lost, or are indistinctly demarcated from them. In the adult brain I know of no appearance in the nerve centres so fallacious as that of the

course of the callosal fibres after they have crossed. Looking at a perpendicular section of a fresh brain, or one hardened in spirit, it is absolutely impossible to say definitely where they go to; and hence the idea has gained almost universal credence, that they pass from the cortex of one side to that of the other, simply because the corpus callosum lies between the two hemispheres. This has never been absolutely demonstrated by any known method of inquiry. It is an absurdity to say that a single fibre can be traced in its continuity from side to side, seeing that the callosal fibres do not all lie in the same plane. Physiologically, there is literally no evidence to show that this mass of white matter is a means of uniting the functions of equivalent areas in the two cerebral hemispheres; and it is as yet unproved, even if it were a commissure, that unity of function would thereby result from duality of structure. In fact, the whole commissural theory of the corpus callosum has arisen simply from its lying between the two hemispheres, and from its fibres, in their middle course, seeming to run transversely, or nearly so, when roughly examined.

It is only when the brain is specially prepared for the purpose that the true destination of its fibres after crossing the middle line can be discovered. By this means there is brought out an appearance in Man and the lower animals which I have never seen figured in any work on the subject, and which careful observers, such as Flechsig, have either not observed or have ignored.

Were it true that the fibres are commissural, how is it that destructive lesions in one cortex do not affect the other? I have in my possession at present the brain of a woman in whom the first and second frontal convolutions have been completely destroyed, so far as the symptoms and morbid appearances indicate, from the time of birth, and yet the corresponding convolutions on the opposite side are quite intact. How is this to be accounted for on the commissural theory? I cannot conceive, if the one side is so intimately bound up with the other, that some mutual influence should not be exerted in a case such as this, where the deficiency has been caused at so early a period of life. Gudden's and

Monakow's experiments have shown that when certain regions of the cortex are excised in newly-born animals, the parts with which they are in connection are under-developed when the animal is fully grown. Why is it then that in the case of this large so-called commissure, if such it be, the same does not hold good? There seems to be a discrepancy here, which, until explained, should retard us from accepting as proven the usually recognised opinion of the connections and functions of the corpus callosum.

However great the difficulty may be of following the course of the callosal fibres in the adult, this in great part disappears when the embryonic brain is the subject of observation at the age I have before mentioned. Flechsig ('Die Leitungsbahnen im Gehirn und Rückenmark,' 1876), evidently taking it for granted that the corpus callosum is a commissure uniting different zones or areas of the cerebral cortex, has failed to notice the very remarkable appearance presented by it in from the third to the fourth month of pregnancy. He dismisses its consideration in a few words (p. 49), and says, "he will not find occasion to return to this part of the brain in the present memoir." In his succeeding publications I cannot find anything bearing on the appearances I have seen, and therefore must conclude that he has not noticed them. From this oversight I fear that his scheme of the brain, as set forth in his 'Plan des menschlichen Gehirns' (Leipzig, 1883), requires to be reconsidered. One of the chief drawbacks of his now long-famous work on the subject of the conducting paths is that he gives in his illustrations so few drawings of the brain when cut perpendicularly. I can find only one (Pl. III. Fig. 5), and in this, unfortunately, the corpus callosum seems to have been torn. The course of the callosal fibres after they have crossed is not depicted in it, chiefly, I should think, because the brain had not been specially prepared with this object in view, but also because the child from whom it had been taken was too far advanced in development (52½ cm. long, and had lived for 2½ days). It is in a much younger fœtus that the callosal fibres are to be found in their isolated state, and the reason for this is, as before referred to, that they are laid down long before

those of the peduncular tract coming down from the fissure of Rolando. Thus if the brain of a fresh human fœtus about the fourth month of pregnancy be prepared by the method I employ, the corpus callosum after passing into the hemispheres can be traced with perfect accuracy throughout its entire course to its ultimate destination. Its rudimentary fibres are all deposited before the radiation of the peduncular tracts is visible, and hence it follows that if the proper age be selected, we possess in such a brain a means of studying the course and connections of the callosal fibres in their isolated state, and unc mplicated or obscured by the many other tracts that afterwards appear. The action of certain staining reagents is a great help in following out the line pursued by them.

The Corpus Callosum in a Human Embryo about Four Months old.

The embryo from which the following account is taken was said to be about the fourth month of intra uterine existence. It looked as if this were true, and the state of the primary fissures in the cerebrum tended to confirm the opinion. It was received in good condition, and the brain after being hardened, or rather *toughened*, for four weeks in Müller's fluid and soaked in my freezing fluid, cut to perfection. I may mention that I have confirmed all the facts I am about to describe in many other embryos both of man and the lower animals.

The principle upon which Flechsig's work was based is that the various cerebro-spinal nerve tracts become medullated at different periods, the whiteness of the tracts which are medullated serving to distinguish them from those which are not. In former times "secondary degeneration," or the Wallerian method, was that chiefly relied upon; but as there are evidently some tracts that do not readily degenerate secondarily, a greater degree of certainty can be reached when the two methods are combined. The tracts in the spinal cord have thus been definitely laid down, and in the medulla oblongata the course of most of the nerve bundles is known. When we come to the brain, however, much still

remains to be done, the *centrum ovale* being as yet practically a *terra incognita*.

The brain of a human fœtus about this period is comparatively smooth on the surface. There are indications of the presence of the great fissures, but, as yet, the convolutions, with the exception of the island of Reil, have not appeared. Thus there is a large wide gap representing the Sylvian fossa, with the island lying exposed in it, still uncovered by the operculum. There are also indications of the first and second frontal sulci, but the fissure of Rolando is either absent or forms the slightest depression. On cutting into the brain, it is evident that the corpus callosum has advanced much beyond other parts in development. Relatively to the volume of the brain it actually appears larger than in the adult, and not only so, but the whole callosal tract can be seen passing, as I hold it does, round the ventricles down to the inner and outer capsules. This is rendered particularly evident when the brain is frozen by my method, and polished on the surface in the microtome with the section knife. The callosal tract can then be, distinctly enough, followed from the middle line to its termination.

The whole relationship of the parts, however, is rendered much more evident when a thin section is cut and stained either in solution of perosmic acid, of acid-fuchsin, or of some nuclear staining reagent such as methyl-aniline, carmine, or logwood. I shall describe the appearances presented by each of these first, and then draw certain conclusions from them.

The Perosmic-acid Preparation.—I always stain the tissue after it has been hardened—a more delicate method than that of staining the fresh tissue. I simply lay the section in a very weak solution (1 to 800) for a night, and subsequently mount it in Farrant's medium. The preparation so obtained serves both as a naked-eye and as a microscopic object, but it is most instructive as the former.

The first glance of such a preparation shows that the fibres of the corpus callosum after crossing *do not radiate* into the cerebral medulla to reach the cortex of the opposite side. On the contrary, those issuing at the side remain as *a compact ribbon-like band*, which twists upwards, outwards, and

downwards, round the ventricular cavity, and ends by entering, or rather forming, the inner and outer capsules by splitting over the lenticular nucleus. It arches much higher up in the embryo than in the adult, because the ventricle at this age is still large, and projects higher up at the sides than when the brain is fully formed. The ventricular cavity has somewhat of a Y shape, the two upper limbs corresponding to the lateral ventricles, while the lower may be taken to represent the relationship of the third. It is round the upper limbs of the Y that the callosal tract turns.

The action of the perosmic acid is to give an olive-green or light-brown tint to the whole section, but it stains the callosal tract of a dark brown, so that it becomes almost diagrammatically mapped out from all the surrounding parts. The cause of this is that *the callosal fibres are advanced in development, at this period of utero-gestation, far beyond any other nerve tract in the brain.* For while the greater part of the cerebral medulla at this time is composed simply of gelatinous tissue with embryonic cells lying in it, the callosal tract, from beginning to end, contains dense bundles of rudimentary nerve fibres.

When a small portion of the callosal tract, in a fœtus of this age, is teased out and examined with a magnifying power of 450 D., the fibres of the corpus callosum have the following appearance:—They are extremely fine, and are arranged in dense bundles. In each bundle there are to be seen usually, from five or six, up to ten or twenty individual fibres. The faintest line indicates the rudimentary axis-cylinder, while round about this is a covering of finely granular material. Sometimes it happens that the axis-cylinder becomes divested of this granular sheath, and when so, its extreme delicacy becomes apparent. The granular matter is usually so abundant and so dense, that it in great part conceals the axis-cylinder.

Glacial acetic acid, however, has the effect of rendering it more apparent, but it is best seen when accidentally the granular coating has been removed by pressure. So far as I have observed, absolute alcohol and ether do not dissolve this granular sheath, but glacial acetic acid or potash both render

it much clearer even in a preparation which has been hardened. It is, therefore, in all probability not fatty as yet, and the latter reaction would seem to indicate its albuminous nature. At this stage of development I could not find any medullated fibres, and, therefore, the darkening of the tract could not be due to a fat-containing medullary sheath. The corpus callosum of an adult, when treated with perosmic acid in the same way, becomes perfectly black within 24 to 36 hours, and this is due to the large proportion of medullated fibres contained in it. The deepest stain I was able to produce in this embryo, however, was a deep brown.

The outer and inner capsules have already been referred to as being present, and it has just been stated that the callosal tract, after winding round the ventricle, forms them by splitting over the head of the lenticular nucleus. They present most of the characteristics of these structures in adult life. Thus the fibres of the inner are aggregated into bundles, which, on account of their oblique antero-posterior direction, are usually cut across in a perpendicular transverse section. Between the bundles of nerve fibres are septa of grey matter, continuous with the caudate nucleus on the one hand, and the lenticular nucleus on the other. Both capsules give a dark brown reaction with perosmic acid, the inner more than the outer.[1] There is no other part of the brain which darkens in this way, and hence my theory of the continuity of the capsular and callosal fibres gains support from this.

Not only do certain localities along the course of the tract stain deeper than others, but in the part of it which sweeps round the ventricle the perosmic acid shows, by its differential staining, that the tract consists of three layers or strata. The middle of these stains darkest, and hence I am led to suppose that it is the most highly developed. It can be traced from the middle line round to the inner capsule quite continuously. For the purpose of explanation, I shall call that part of the corpus callosum which is brought into view by separating the hemispheres, the *tectorial* part; and it can be

[1] The degree of staining depends upon the strength of the perosmic-acid solution. If a half-per-cent. solution be employed, the callosal tract and the two capsules become of a dark sepia brown and very opaque. A much more delicate reaction is obtained when the perosmic acid is more diluted.

readily noticed that the middle stratum forms the greater part of this. The other two strata become very attenuated as they approach the tectorial part, and finally cease to exist before the middle line is reached. The two parts of the preparation which are deepest stained with the perosmic acid are the middle stratum of the callosal tract in the tectorial part, and the inner capsule. The outer capsule is not so deeply tinted, nor is the part of the callosal tract which turns round the apex of the arch of the ventricular cavity. The staining is deeper, as before mentioned, in the middle stratum than in the other two, and on this account it can be readily traced from the tectorial part round the ventricle into the inner capsule. Few if any of its fibres seem to enter the outer capsule, which, as we shall afterwards see, appears to be more a continuation of the *upper* stratum.

The fibres, therefore, as they issue from the side of the corpus callosum, turn downwards, and form at this early period evidently the greater part, if not the whole, of the two capsules. They have been gathered in from the cortex of the opposite side, have passed through the *tectorial* part of the callosal tract, and have subsequently turned downwards. As regards the exact regions from which they arise, it is somewhat difficult to give precise details, so far as the embryonic brain at this period is concerned. The area being large, they are consequently less compactly aggregated than they are when they enter the *tectorial* part, or subsequently in their course downwards. At the same time they do not seem to be quite so highly developed as the fibres in these parts of the tract. They do not stain so deeply with perosmic acid, and when examined microscopically, they appear to be very rudimentary. A radiating arrangement is, however, distinctly apparent in the fibres coming from the cortex, most evident towards the vertex. In the adult brain a great mass of the callosal fibres comes from the vertex, specially from the margin of the longitudinal fissure. They sweep inwards with their concave side to the middle line, and it is also from this neighbourhood that the most of the callosal fibres in the embryo at this period seem to be derived.

The Acid-fuchsin Preparation.—The action of this substance

upon nerve tissues, especially those of the brain and spinal cord, is now widely known. I am inclined to believe, that we possess in it one of the most useful of all staining reagents for the purpose of tracing the course of certain nerve bundles. Its action was originally described by Weigert ('Centralblatt f. d. med. Wissenschaft,' 1882), and since then many workers on the normal and morbid nerve centres have been able to confirm and add to what he said of it. It differs from all other staining reagents in the fact, that apparently in the presence of a chrome-potash salt, or at any rate when the tissue has been hardened in such, it stains *the nerve fibres*, and leaves the grey matter with its cells uncoloured. I was naturally led to employ it for this brain with the view of staining the callosal tract. The particular dye is known as Acid-fuchsin "S" No. 130 of the Baden Aniline manufactory, and the sample I have of it I procured from Dr. Grübler, of Leipzig.

It was questionable whether, with the rudimentary fibres of the corpus callosum, the same reaction would be given as with those which were fully developed. I found, however, that the callosal tract in the embryonic brain stains, if not so differentially as in the adult, yet so much more deeply than other portions of the cerebral medulla, that it forms to the naked eye a pink-coloured band, as clearly drawn out as if it had been done with a camel-hair pencil. The whole tract and the two capsules give this reaction, so that the continuity of the one with the other is rendered extremely evident. Microscopically it is seen to be due to the coloration of the rudimentary fibres, not to that of the nuclei which are abundantly interspersed between them.

As, however, methyl-aniline gives, if anything, a still more differential picture when the preparation is examined microscopically, I shall describe the minute appearances as seen in one stained by this latter substance.

The Methyl-aniline Preparation.—Flechsig has pointed out, that when a tract begins to become medullated, the nucleated cells within it increase greatly in number, and if such a tract be treated with a nuclear staining reagent, the coloration forms a trustworthy guide to its position, both as a naked-eye object and microscopically. The same nucleated cells are seen in

abundance in the callosal tract at this age, and when stained they form an important indication of the course of its fibres. Several nuclear staining materials bring out like appearances. The one I have found best is methyl-aniline. Logwood does very well, but the former is more delicate and differential, and various degrees of staining can be obtained with it better than with logwood. I overstain the preparation, and wash out to the proper degree with dilute acetic acid and alcohol. The preparation is mounted in Farrant's solution, as previously.

The callosal tract is again seen to consist of three layers; but there is this difference in regard to their staining, that the uppermost has stained deepest, the lowest least so, and the middle presents a medium amount of coloration. The lowest layer appears to be purely cellular, the cells are all rounded, and they possess large nuclei which stain vividly with the methyl-aniline, more intensely even than those of the cortex. It measures from a quarter to a half a millimetre in thickness. Its course is to be traced from the tectorial part entirely round the ventricle, and continuously downwards to the rudimentary caudate nucleus. It is a remarkable fact, that the nearer the caudate nucleus is approached, the more intense the staining becomes, until in the caudate nucleus itself a distinct reaction is produced by this dye, the colour of the cells contained in it being a bright blue. Near the septum lucidum the coloration is much less intense, and the layer becomes so much attenuated that it is gradually lost before reaching the middle line. The same intense affinity for staining media characteristic of the cells contained in this layer is seen when logwood is employed, but to a minor extent, methyl-aniline, as just mentioned, giving a blue *reaction* with its cells. I could not distinguish any fibres within it even of a rudimentary character, nor could I find at any part fibres approaching it as if about to become incorporated with it. Its cells seemed to pass continuously into those of the still rudimentary caudate nucleus. What this layer represents I cannot definitely say. In the *adult* brain, there are always seen in this part of the corpus callosum a few bundles of fibres, turning sharply downwards and inwards to the caudate nucleus. Some of them enter it, and I think it

quite possible that, later on, this layer becomes converted into these fibres, and so still retains its primary connection with the caudate nucleus. I shall not commit myself, however, to this view, until further inquiring into the matter.

The caudate nucleus at this period is entirely cellular. Fibres cannot be seen entering it from the inner capsule, and the cells are so closely packed, that when stained as described it looks like a uniform intensely blue mass. Lying outside of it, between it and the inner capsule, is a little acutely oval-shaped cellular piece of tissue, much less intensely stained, but composed of the same kind of cells. It is present in all the sections from this neighbourhood; and were it not for the sharp differentiation brought out by the staining, I should have included it simply as part of the caudate nucleus. It sends processes between the bundles of fibres of the inner capsule, and is very vascular. It stains exactly in the same manner as the lenticular nucleus, and the processes or septa which run in between the inner capsule bundles unite it directly with this nucleus.

Passing now to the middle stratum of the callosal tract, it is seen to be composed in the tectorial part of dense masses of fine fibres, with only a few nucleated cells between them. It measures from one to one and a half millimetres in thickness. Tracing it along the callosal tract, the same characteristics distinguish it until it reaches the vault of the ventricular cavity. Here, just as the tract begins to turn round, brightly stained nuclei become visible in it, and they continue until the callosal tract divides into the outer and inner capsules. In these the nucleation almost entirely ceases. The nuclei are surrounded by a little very delicate protoplasm which does not stain, and the whole cell, as a rule, is not larger than a leucocyte. They are distributed in rows between the nerve fibres, so that in a preparation such as this in which they are brightly stained, they indicate in a very demonstrative manner the course followed by the bundles of delicate nerve fibres. When more highly magnified (350 D.), they are found to exactly correspond to the inclination of the several nerve bundles.

Tracing this middle and largest stratum of the callosal tract

downwards after turning round the ventricles, it is evident what becomes of it. It splits into the outer and inner capsules over the head of the lenticular nucleus. Not only does it split into these, but at this period of development *the entire inner capsule and a great part of the outer are formed by it.* After the most careful search I cannot find any other system of fibres going into the capsules—and yet they are perfectly distinct, and appear quite as advanced in development as any part of the callosal tract.

This, I hold, entirely coincides with the view announced by me in my communication to the Royal Society. I there stated, that I believed the anterior limb of the inner capsule to be composed almost entirely of crossed callosal fibres. Certainly some bundles enter it from the first frontal convolution of the same side, and probably other tracts may be derived directly from the tip of the frontal lobe, such as Meynert's anterior peduncle of the thalamus. This, I grant, may be true, but what I still uphold as entirely borne out by the examination of the embryonic brain, is that the main bulk of the fibres of the anterior limb of the inner capsule is callosal.

The most superficial of the three layers of the callosal tract is also, in the brain I am describing, the most highly nucleated. It is seen to arise in a very attenuated row of cells, which appears to be continuous with a delicate cellular layer lying on the upper surface of the tectorial part. It measures from half to one-and-a-half millimetres in thickness. Starting then with this attenuated internal extremity of the most superficial of the three layers of the callosal tract, it is seen rapidly to increase in bulk outwards, until opposite the highest point of the ventricular cavity, its maximum of breadth is obtained. It here forms a pyramid-like projection, and the particular shape thus imparted to the arch of the "crossed callosal tract" persists in some regions of the brain in adult life, more particularly in the parietal. As a rule, however, the pyramidal shape is lost when the brain is fully developed, so that the arch of the "crossed callosal tract" becomes in the adult more or less rounded. Traced further downwards, it is seen that the upper stratum becomes incorporated with the middle, and I think that most of its

fibres ultimately pass into the outer capsule. It is intensely nucleated throughout, and between the rows of nuclei fibres less advanced in development than those of the middle stratum are contained.

The pyramidal projection formed by this stratum is easily accounted for when examined microscopically. The fibres and their corresponding rows of nuclei are tilted upwards at this portion of the tract, and are much more acutely arched than in any other part. It looks as if they were driven into this position by the ventricle, the pyramid-like contour of the tract corresponding in shape with the apex of the vault of the cavity.

Such being the composition of the callosal tract at this age, an interesting question comes to be whether there are any signs as yet of the peduncular tract, described and figured by Flechsig, in a viable fœtus of 52½ cm. long ('Die Leitungsbahnen,' &c., Pl. III. Fig. 5, *c.c*), and which one can see with little difficulty even in an adult brain when properly prepared. It will be noticed from the drawing he gives of it (naked-eye appearance only) that it comes down from the margin of the longitudinal fissure. He describes it thus at page 29:—"I found," he says, "in the medulla of the hemispheres a white mass which deserves minute examination, both on account of the time of its appearance, and of its special morphological properties. It was apparent in frontal sections which ran through the upper parietal region opposite the meeting-point of the two central convolutions, more especially the upper and anterior part of the posterior. It consisted of a small sharply demarcated white streak, which, leaving the external part of the capsule, that is to say, the neighbourhood of the divisions of the lenticular nucleus, ran first somewhat outwards, curved for about ½ cm. above the ventricle, was then sharply bent inwards, and finally passed upwards to end in the part of the posterior central convolution, which lies nearest the fissure of Rolando. While this band hardly reached up to the cortex in a 2½ days old child, it passed up to within ½ cm. of the same in one 9 days old."

In my communication to the Royal Society on the subject of the corpus callosum, I stated that the "corona radiata," as

usually described, does not exist. The common idea is that the fibres of the inner capsule coming up from the peduncle and basal ganglia, all radiate outwards into the cortex of the same side. That is to say, the fibres simply spread from the inner capsule in all directions, and become attached to the hemisphere on the same side.

With this view I cannot agree, and the more I work at the matter, the more I become convinced that it is erroneous. Flechsig, in the passage I have already quoted, traces a thin white medullated band from the inner capsule to the upper part of the fissure of Rolando, in the neighbourhood of the paracentral lobule. This appears in the fœtus when viable, and almost at the full time of utero-gestation. As he figures it (Pl. III. Fig. 5, *c.c*), the band appears very slender—a mere twig compared with the enormous mass of the inner capsule or centrum ovale. He shows that this is directly continuous with the inner capsule, and that it comes from that region of the cortex which corresponds to the upper part of Ferrier's motor area. It further is equivalent in bulk, it will be admitted, to the tract which degenerates in an old destructive lesion in this neighbourhood, and hence there is little doubt that it consists of fibres which pass directly from the pedunculi upwards. He does not say, however, that the remainder of the so-called *corona radiata* can be traced in the same way from inner capsule to cortex. No doubt certain special tracts, such as Gratiolet's band to the occipital lobe, can, but the enormous mass of the corona radiata as described cannot be directly followed out in the same way. The band going to the motor area, as above described, forms a mere fraction of the fibres of the inner capsule, and it alone can be distinctly traced in its development from the inner capsule to the cortex of the same side.

Now in any adult brain these direct fibres can be readily seen when prepared in the method formerly described by me ('BRAIN,' July, 1883). They come from the margin of the longitudinal fissure, are aggregated into comparatively coarse bundles, and finally enter the inner capsule. I trace them forwards in the adult brain much further than Flechsig does in the embryo. I do not think that they are derived merely

from the margins of the Rolandic fissure, or from the paracentral lobule; for I find them also coming down from the first frontal posteriorly. They are certainly, however, most abundant at the line of the Rolandic fissure, and the bundles here are coarser than elsewhere. They seem to be entirely confined to the inner capsule in their progress downwards. That some of them also enter the outer capsule I am not prepared to deny, but it has always seemed to me that the outer capsule, in its inner half at least, is composed of crossed callosal fibres derived from the "crossed callosal tract."

In the fœtus of four months, however, the inner and outer capsules are well formed and filled with developing nerve-fibres, while the band running up to the margin of the hemisphere as described by Flechsig is non-existent. The capsules, further, can be distinctly traced continuously into the corpus callosum along the callosal tract, as I have just described. Here then is a system (the callosal) well developed before any direct fibres from the cortex of the same side have made their appearance. The two capsules are of large size—relatively to the bulk of the brain of very large size, and they correspond in dimensions to the bulk of the callosal tract. If then the "corona radiata" of the inner capsule sends its fibres to the cortex of the same side, how is it that where the "corona radiata" is not present, the two capsules are yet laid down with the shape and features which characterise them in adult life? The band described by Flechsig as coming down from the motor area is one of the best marked of all the systems of the so-called "corona radiata." Here, however, in this four-months-brain there is not a trace of it, while the bundles of fibres in the two capsules are perfectly distinct. The fact, that the callosal tract can be traced macroscopically and microscopally to enter the capsules in the brain of this age, affords, I think, the explanation; and this explanation I hold lies herein, that not only in fœtal, but in adult life, the inner and outer capsules are largely composed of fibres which are callosal in their derivation. As development goes on from four months upwards, *direct* bands undoubtedly pass into them from various parts of the brain. These, however, form a small part of their bulk, compared with those of callosal origin. I

think, therefore, without drawing any very detailed conclusions from the foregoing facts as seen in the four-months-brain, it may fairly be granted that these facts undoubtedly afford strong support to the views expressed by me in my communication to the Royal Society.

In summing up the main conclusions that may be inferred from the study of the four-months-embryo, I would say that they all tend to refute the idea of the corpus callosum being a commissure, and to support that of its being in reality a decussation of *certain* of the cortical fibres. These arising from the cortex on one side, pass through the tectorial part of this body to the opposite, and after circumventing the ventricular cavity, turn downwards to form the greater part of the inner capsule, at least in its anterior limb, as well as the inner half of the outer capsule.

If this then be the course of the callosal fibres in the middle part of the cerebrum, what is the disposition of those which take their origin from the frontal tips? The usual idea, as every one knows, is that the callosal fibres coming from the one frontal tip, pass through the genu of the corpus callosum, to gain a corresponding situation in the opposite tip. In this course they are supposed to run horizontally. I have long been persuaded that this idea is erroneous, but it was not till I undertook the present inquiry on the fœtal brain that I could actually demonstrate it. The course pursued by the callosal fibres in this part of the brain, is a much more difficult matter to demonstrate in the adult than might be supposed. It might be thought that the track of a large mass of fibres like this could be easily followed up. No greater error could be made. The intertwining of different systems is so complex, that I believe it is only in the fœtus, where the callosal system is alone developed, that it is to be clearly made out.

The reason for the peculiar arched course of the callosal tract, as described, is obvious. It is to allow the fibres to circumvent the lateral ventricle, and if my idea as to the course of these fibres be correct, the same obstacle has to be overcome by those fibres derived from the extreme anterior frontal region. What I have found both in the fœtus and the

adult is that, instead of the callosal fibres derived from the anterior frontal region arching between the frontal tip of one side and that of the other, the fibres coming from, say, the left side, pass back horizontally to the genu corporis callosi, cross in this more or less obliquely, and, gaining the right side, turn ultimately backwards into the inner capsule. Now the anterior horn of the lateral ventricle lies considerably further forwards than the genu of the corpus callosum, and hence, in order to circumvent this obstacle to their gaining the inner capsule, they have to follow a circuitous course around it. When I found that the callosal tract was so well defined in perpendicular sections of the above-described fœtal brain, it immediately struck me that if my theory were correct, a *horizontal* section made through the tip of the frontal lobe ought to show the callosal fibres turning round the anterior horn of the ventricle, in order to enter the inner capsule. This proved to be actually the case, far beyond my expectations. A band quite as distinct as that seen in perpendicular sections is to be found in a fœtus of this age in horizontal sections, it runs from the corpus callosum forwards, outwards, and backwards, around the anterior horn of the ventricle. In the adult brain this band becomes so interwoven with other medullated fibres that it cannot be distinctly demonstrated.

As regards the future course of these fibres I cannot say anything further at present, as it would require a great wealth of illustration to make what I should like to say on the subject comprehensible. The main fact that I would wish to record in this brief communication is that which has been chiefly dwelt upon, namely, that the examination of the embryonic brain supports the conclusion I formerly arrived at of the corpus callosum being not a commissure, but in reality a decussation similar to that of the anterior pyramids.

ON SOME OF THE RARER FORMS OF MUSCULAR ATROPHIES.

BY J. DRESCHFELD, M.D., F.R.C.P.,

Professor of Pathology, Victoria University: Physician to the Royal Infirmary, Manchester.

THERE is scarcely any subject of the whole of neuropathology which presents such a large field for observations and enquiries as the chapter on muscular atrophies. Thanks to many important investigations, we are beginning to understand more clearly, and classify more correctly, the many varied forms of diseases characterised chiefly by trophic changes with more or less paralysis in the muscles.

Much, however, remains yet to be done, and many gaps will yet have to be filled up, before the pathology of the different forms of muscular atrophy may be said to be definitely settled. If, in spite of the numerous recent observations, there still remain many points of dispute, the reasons are not far to seek; many of the incurable cases run a very chronic course, and do not give us the opportunity of a pathological examination; others undergo marked improvement, and even complete cure, and thus also escape the pathologist; while many, again, though they may differ materially both as regards the nature and localisation of the disease, present a certain similarity in the symptoms. As a small contribution I beg briefly to relate some rarer forms of muscular atrophy which I have observed during the last few years.

In classifying muscular atrophies we may still be guided, though with certain restrictions, by the principle laid down by Waller, that the spinal cord exercises a trophic influence over the motor nerves and muscles, and that the motor ganglia-cells in the anterior horns form the trophic centre. Lesions of the brain, therefore, as long as the spinal trophic centres are unaffected, will not produce muscular atrophies, and when such

muscular atrophies result or are associated with brain-lesions, we have either, as in the cases recorded by Pitres, marked atrophy of the motor ganglia-cells, or, as in the case reported by Kojeronikoff,[1] a degeneration of the whole of the pyramidal tract propagated to the motor ganglia-cells in the cortex of the brain.

A number of atrophies will thus result from a primary affection, either inflammation or degeneration of the large motor ganglia-cells. To this group belong, as is well known, infantile paralysis and the acute poliomyelitis of adults; progressive muscular atrophy; subacute and chronic polio-myelitis and amyotrophic lateral sclerosis, and the corresponding affections of the nuclei of the motor cranial nerves, namely acute and chronic bulbar paralysis (glosso-labial pharyngeal paralysis and Wernicke's polio-encephalitis superior, acute and chronic), which seems to correspond to the ophthalmoplegia of Hutchinson and Mauthner.

More recent observations have taught us to separate from this group several types which formerly were classed with it; thus from progressive muscular atrophy we must separate Erb's juvenile form, chiefly characterised by the limitation of the affection to the muscles of the shoulder girdle and arms, and in some cases the thigh, while the forearms and hands remain free, by the absence of fibrillar twitchings, and by the absence of degenerative reaction; another form is that described by Charcot and Déjérine, where the facial muscles are the first to be affected. Again, many cases of chronic poliomyelitis are now looked upon as belonging to the group of peripheric neuritis, and even the amyotrophic lateral sclerosis is looked upon by some, we think wrongly, as a form of progressive muscular atrophy.

(Within the last six years, two cases showing during life the typical symptoms of amyotrophic lateral sclerosis have occurred in the practice of my colleague Dr. Leech, in the Manchester Infirmary; and in both cases the microscopic changes of the spinal cord, and also in the medulla, showed the well-marked affection of the motor-ganglia cells with sclerosis of the lateral columns. As both cases will be

[1] 'Arch. de Neurol.,' 1884, No. 18.

published by Dr. Leech, I need not dwell on them further here.)

Besides the primary affection of the motor cells, there are some other spinal diseases giving rise to extensive muscular atrophies, and where the motor-ganglia cells are chiefly concerned in the disease process; to this group belongs the perependymary myelitis of Hallopeau, the syringo-myelia and the diffuse glioma (of which the latter two have been more recently studied), and the rare cases of hæmorrhage into the spinal cord.

In other affections of the spinal cord, such as locomotor ataxy, tumours of the cord, syphilitic diseases of the cord, the ganglia-cells may be implicated secondarily, and muscular atrophies of great extent may ensue.

In a second great group of muscular atrophies the spinal cord is found normal, and the affection resides chiefly in the peripheric and intermuscular nerves, thus causing separation of the muscles from their trophic centre, and hence muscular atrophy. Our knowledge of this affection, as far as it concerns the idiopathic non-traumatic forms, is of recent date, and we may now include the multiple peripheric neuritis of Leyden, lead paralysis with atrophies, alcoholic paralysis with atrophies and some at least of the paralyses and atrophies, following diphtheria, typhoid and other zymotic diseases and the epidemic disease, Beri-Beri, besides the secondary atrophies, due to wounds of nerves, pressure by tumours, lepra, &c. As intermediate between the first and second group, we may consider the atrophies following affections of the membranes of the spinal cord, notably those produced by pachymeningitis.

In a third group neither cord, nerve root nor peripheric nerves are affected, and the affection is a primary myotic. Besides the juvenile form of Erb, and Charcot, and Déjérine's form, this group also includes pseudo-hypertrophic paralysis.

(It has been held by some, that probably some of the atrophies of this group of affections may have their starting-point in the terminal muscle plates; as yet we have no observations on man, and considering the difficulty of such investigations, this is not to be wondered at. Gessler[1] has

[1] 'Die motorische Endplatte;' Leipzig, 1885.

quite recently published some observations on changes in the terminal muscle plates observed after section of peripheric nerves in animals. He found changes mainly in the granular nuclei of these plates. As these changes were found along with the changes in the peripheric nerves, it cannot be said that our knowledge of the myopathic atrophies has thus been in any way advanced. Nevertheless the subject is one which, no doubt, will receive further attention.)

Lastly we have reflex atrophies, of which those studied by Charcot, [1] and associated with joint-affections, are the best known. In these atrophies it is assumed that the trophic ganglia cells in the cord are irritated in a reflex way by means of the nerves of the affected joint. (In some of the forms of atrophy, as, for instance, in lead atrophy, de Watteville and others believe that the ganglia cells are implicated, though they may not show any changes when examined microscopically.)

In spite of our different subdivisions, it will still be found that the clinical pictures of the several forms vary but slightly, that there are yet some forms which do not exactly fit into any of the given groups, as will be seen from some of the cases described below. In describing the cases which have come under my observation, I will group them, as far as possible, according to the classification just given.

The cases which I have observed of progressive muscular atrophy (Aran Duchenne's type) have been of the ordinary character, with the exception of two which have been under observation for many years, and differ from the ordinary type in two important particulars; namely the affection, though commencing slowly, remained limited to the small muscles of the hands, and has now continued stationary for several years; the atrophy was associated with extensive analgesia and loss of the sense for temperature; whilst the common tactile sensibility, the sense for weight, and the muscular sense remained normal. Of these two cases I will give one more fully, the second resembling this in almost every particular.

[1] 'Progrès médical,' 1882.

Case I.

A. G. has been under observation since 1878, when he was admitted first as an out-patient and then as an in-patient into the Manchester Infirmary. On his admission, Nov. 19, 1878, the following notes were taken: Pat., æt. 23, mechanic; the father is living and healthy; the mother and one sister died of consumption; has two sisters living, who are in perfect health. The patient himself has enjoyed good health till a year before admission; has been regular in his habits, and has not suffered from rheumatism or syphilis. Twelve months before admission he noticed his fingers getting cold and numb, and found that he could not execute finer movements, such as picking up a pin; the weakness gradually increased, and he lost power in both hands; he often noticed scratches and burns on his hands without being able to account for them, and without feeling any pain.

Condition on Admission.—The patient looks healthy, is somewhat spare, and of good intelligence. The examination of the thoracic and abdominal organs reveals normal relations. Pulse 70, regular and fairly strong, temp. normal; skin moist; bladder and rectum unaffected. As regards the nervous system, there are no cerebral symptoms, and no symptoms on the part of any of the cranial nerves; the lower extremities are normal as regards motion, nutrition and sensibility. *Upper Extremities.*—The hands and forearms are seen to have lost a considerable amount of flesh; the small muscles of the hand being especially atrophied; the thenar and hypothenar eminences have completely disappeared; the interossei are considerably atrophied, and both hands present the "main en griffe." The flexors of the fingers, the pronators and the supinators act fairly well. The muscles of the arm, shoulder, neck and trunk are perfectly normal as regards motion. The left hand is slightly more affected than the right. No fibrillar twitchings in any of the muscles.

The tactile sensibility is normal, and the patient can, with his eyes shut, tell correctly the outlines and physical condition of the surface of any object he touches. There is, however,

complete analgesia of the fingers and thumbs, and of the palm and back of hand; it extends also in front, behind, and on the outer side of each forearm quite up to the elbow, while on the inner side the analgesia ceases about two inches below the elbow. There is, however, diminished sensibility for pain along the whole of both arms and shoulders, reaching to the outer end of the clavicle in front and nearly up to the spine of the scapula behind. The whole of the analgesic area shows complete absence of sense of temperature; the patient is quite unable to distinguish between hot and cold. The patient has often burnt his fingers in handling burning coals; he has felt no pain whatever, even though the burn resulted in an ulcer (which, however, healed very readily). The sense for weight, tested in the usual manner, was found to be fairly normal. The patient knew also the exact position of his fingers or hands, when tried in various ways with the eyes shut.

The superficial and deep reflexes are normal in the lower extremities; no tendon reflexes in the upper extremities.

Measurements of the Affected Parts.

Right side: over styloid process	6½ inch.
1 inch above styloid proc.	6¼ „
1½ inch below olecranon	9½ „
Left side: over styloid	6½ „
1 inch above styloid	6 „
1½ inch below olecranon	9½ „

The hands feel cold; their temp. is 95. The parts to which electricity has been applied show a dusky red appearance for a long time after the application has ceased.

Electric-reactions.—With the faradic current it was found that, with the strongest current, no contraction could be produced in the interossei muscles and muscles of the thenar and hypothenar eminences whilst the other muscles reacted fairly well to the faradic current.

Galvanic Reactions.—Dixon Mann's battery. Direct muscular excitation:

Right hand, dorsal interossei ..	KCC	40 cells	20°
	KOC	none.	
	ACC	20 cells	15°
	AOC	40 „	28°

Flexors of Fingers	KCC	15	cells	20°
	KOC	40	„	28°
	ACC	15	„	20°
	AOC	20	„	22°
Extensors of Fingers	KCC	15	„	20°
	KOC	35	„	25°
	ACC	15	„	15°
	AOC	25	„	20°

The left side gave very similar results.

Galvanisation of Nerves :—

Ulnar (right side)	KCC	8	cells	10°
	KOC	20	„	20°
	ACC	30	„	22°
	AOC	30	„	20°

These numbers show degenerative reaction in the affected muscles.

The patient was treated after Dr. Morgan's plan by direct application of electricity (faradic and galvanic current) to the muscles; fine needles were inserted into the affected muscles, and these connected with one pole of the battery; while the other pole was applied to some indifferent point, or sometimes the two poles were connected with two needles, both inserted into the same muscle. For a time it seemed as if the patient improved, but no permanent improvement resulted, and the patient was discharged in March 1879, very much in the same condition as on admission. Since then the patient has presented himself many times, and the disease has made in the last seven years but very little progress. When examined a few months ago, it was found that, as regards the atrophy of the small muscles of the hand, there was little change; the patient stated that the wrist felt weaker, and certainly the forearms had become slightly thinner, as shown by the following measurements:

Right side: over styloid process	$6\frac{1}{2}$	inch.
1 inch above styloid	6	„
$1\frac{1}{2}$ inch below olecranon ..	$9\frac{1}{4}$	„
Left side: over styloid	$6\frac{1}{2}$	„
1 inch above styloid	$5\frac{3}{4}$	„
$1\frac{1}{2}$ inch below olecranon ..	$9\frac{1}{4}$	„

The complete analgesia was limited the same as on admission; but the diminished sensibility to pain observed

before on arms and shoulder had now extended transversely across the chest and back. On the chest the upper limit corresponded to a line a little above the clavicle and its lower limit on the left side to the sixth rib, and on the right side to the fifth rib. On the back the area of diminished sensibility was limited, above by a transverse line at the level of the sixth cervical vertebra, and below by a similar line opposite the fifth dorsal.

The electric examination gave the following results:—

Faradic Current:—

Right side (upper extr.):
Extensor digitor. .. .. 120 mm.
(Du Bois-Reymond's apparatus.)
Flexor carpi ulnaris .. .. 125°

Left side (upper extr.):
Extensor digit. .. .. 110 mm.
Flexor carpi ulnaris .. .. 120 „

Both on the right and left side no reaction even with the strongest current in the lumbrici, abduct. minim. digiti, flexor brevis minimi digiti, abductor pollicis, flexor brevis pollicis and opponens pollicis.

Galvanic Current (direct muscular):—

Right side: Extensors	ΘKCC	20 cells.
	ΘACC	30 „
Flexors	KCC	25 „
	ΘACC	30 „

Left side: nearly the same as right.

In the atrophied muscles, by applying both poles to the muscle it was found that even 50 cells produced no KCC, while ACC was slightly noticed with 50 cells and several times even 45 cells.

Case II.

The second case resembles the case just given very closely.

Martha D., admitted September 1879, æt. 33; married; has four living children, all healthy; has been engaged in mill-work, but left off work long before her affection commenced. She had always enjoyed good health, and only complained of occasional cough. About four years before date of admission

she noticed that she could not grip things so well with her hands, or hold objects properly with her hands; also noticed her hands and forearms getting weaker and thinner. She never experienced any pain in her hands, but was struck with the numbness of her fingers. The numbness she began to notice about three years ago, and for the last two years her fingers have been bent, and she has not been able to stretch them or use them for her household work.

On admission of the patient, it is found that her troubles are entirely limited to the hands and forearms. There is marked atrophy of the small muscles of both hands, and marked "main en griffe." The forearms are also somewhat atrophied, though the flexors and extensors of fingers, the pronators and supinators, show considerable power of motion.

The measurements gave the following results:—

Right side:	above wrist	$5\frac{6}{8}$ inch.
	below elbow	8 "
	1 inch above elbow	$8\frac{1}{8}$ "
	belly of biceps	9 "
Left side:	above wrist	$5\frac{7}{8}$ "
	below elbow	$8\frac{3}{4}$ "
	1 inch above elbow	$8\frac{7}{8}$ "
	belly of biceps	$9\frac{1}{8}$ "

There is marked analgesia of the whole of the hand and forearm, nearly up to the elbow on both sides; on the right side the anterior, posterior and external side of arm, almost up to the shoulder, is analgesic, there is also complete loss of sensibility for temperature over the analgesic part; whilst the common tactile sensibility is perfectly normal.

As regards the electrical reactions, the observation is unfortunately incomplete. The faradic current only was tried, and it was found that the atrophied muscles did not respond even to the strongest current, while the non-affected muscles responded readily. No other part of the muscular or nervous system was found affected; bladder and rectum were likewise unaffected, and the examination of the internal organs showed nothing abnormal, except the presence of bronchitis.

The patient was also treated by the subcutaneous application of electricity, without, however, any material benefit.

I saw the patient again about three years ago, when she was

very much in the same condition as on her admission to the Infirmary. The atrophy had certainly not progressed much, and the analgesia was as well marked as then.

Cases of progressive muscular atrophy in which spots of analgesia occur do not seem to be very uncommon; but I have looked for published cases like the two given above, where there was no anæsthesia, but marked analgesia, and I cannot find any other except the one recorded by Mosler and Landois,[1] which closely corresponds to them.

Case III.

The next case I wish to place on record is one of chronic poliomyelitis, and the publication of this case appears to me to be especially opportune, as some seem to doubt the existence of this disease, believing that many of the recorded cases are cases of peripheric neuritis. There are already some authentic and well-observed cases on record[2] with post-mortem records; the most interesting case, however, is the one recorded by Landouzy and Déjérine,[3] which, though more acute in its onset, belongs yet to this type. In one of the two cases observed by these authors, the patient completely recovered from his spinal symptoms (the abolition of the tendon-reflexes remaining as the only symptom), and died subsequently from pulmonary tuberculosis. The spinal cord, however, showed marked alterations of the anterior grey matter along its whole length, while the anterior roots and peripheric nerves showed no appreciable alterations.

The case which I have to report had been under observation from its commencement to its fatal termination, and the symptoms during life consisted of a gradual paralysis, with marked atrophy, first of the lower extremities, then of the muscles of the trunk, and then those of the upper extremities; the medulla remaining free to the end. There were no sensory troubles, and bladder and rectum remained normal. The tendon-reflexes in the lower extremities were absent, while

[1] 'Berl. Klin. Wochenschrift,' 1868, p. 458.

[2] See, as regards literature, Ross, 'Diseases of the Nervous System,' 2nd ed. vol. i. p. 912; and Erb, 'Brain,' 1882.

[3] 'Revue de Méd.' 1882, Nos. 8 and 12.

those of the upper extremities became marked towards the end. The post-mortem examination showed the affection limited to the anterior horns, except in the cervical and upper dorsal region, where slight sclerosis of the lateral columns was observed. The nuclei in the medulla were found healthy; there was, however, found a small recent hæmorrhage in the nucleus of the pneumogastric, which probably accounted for the marked dyspnœa during the last days of the patient's life and the somewhat sudden termination, together with some other slight changes in the medulla.

The following is a brief abstract of the case :—

Wm. S., admitted into the Infirmary, Dec. 2, 1881; died June 16, 1884.

Soon after admission the following notes were taken: Æt. 36; minder in a mill; married; no children. Father and mother died when patient was still very young.

The patient had been employed in a cotton mill for twenty-six years, and had always enjoyed good health; he had been abstemious in his habits, a moderate smoker, and had never had any venereal disease.

In March 1881, while at work, he had a fainting fit; but this passed off without leaving any trace, and he was able half an hour after the attack to walk home, and went to his work the next day. Some weeks after the attack he noticed a gradual weakness of his right foot and leg, and he found that on walking he had to drag the right leg slightly; he also noticed the right leg to get thinner and flabbier. He, however, never experienced the least pain.

On admission, the patient presented a healthy appearance, was well-nourished and of ruddy complexion. The circulatory, respiratory, and chylopoietic system appears normal; the urine has sp. gr. 1020, is acid, and contains neither albumen nor sugar.

The brain, special sense-organs and cranial nerves are normal; likewise the muscles and nerves of the trunk and upper extremities. The left lower extremity shows no changes relating either to the motor, sensory, or vaso-motor nerves, and the only changes observed relate to the right lower extremity.

The patient is unable to perform dorsal flexion and adduction of the foot and toes; the foot cannot be abducted, and the arch of the foot is flattened; the patient is able to flex and extend the knee, also flex and extend the right hip very well—perform adduction, abduction and rotation of the right lower extremity with ease; yet all these muscles on the right show, when tested, less power than the corresponding muscles of the left lower extremity. The muscles on the right side feel flabby, and there is considerable atrophy, as shown by the measurement.

	Right.	Left.
Mid-calf	11½ inch.	12½ inch.
2 inches above knee	13 „	14½ „
Mid-thigh .	15 „	17½ „

The sensibility is perfectly normal both to touch, pain, temperature, and pressure. The muscular sense is intact.

The patient's walk shows the characteristic appearance of the paralysis; the right foot hangs down and is not raised from the ground; in taking the steps the knee is flexed and the foot thus raised, which falls down again at the next step in a flaccid condition.

The right patellar tendon-reflex, which was still present on admission of patient, but diminished when compared to the left, soon disappeared altogether.

On testing the electric relations of the muscles of the right leg, it was found that the tibial. antic., the peroneus and extensor longus digit. scarcely answered to the strongest faradic current; the gastrocnemii, flexor long. digit. and tibial. anticus answered better. (The galvanic reactions were not tried till later.)

The patient left the Infirmary on March 8th, 1882, very much in the same condition as on admission. He went to the Convalescent Hospital at Cheadle for some time, and then went home, when he became gradually worse.

He was readmitted on Feb. 16, 1883, when his condition was found very much worse, as will be seen from the following report, taken shortly after the patient's readmission.

The patient lies in bed, and cannot rise from the recumbent posture without help, from weakness of the muscles of the

back; but, sitting up, he can easily straighten his back by contraction of his lumbar muscles.

There is only slight hardening of the recti abdominis on their contraction.

Similarly he cannot get from the sitting to the recumbent posture gradually, but goes down with a bump. He is just able to stand with support, but is quite unable to walk. The superficial (cremaster, abdominal, epigastric and scapular) reflexes are slightly marked.

Lower Extremities.—The right leg and thigh is completely paralysed, and the muscles considerably wasted. There is not the least rigidity about the joints, and the extremity remains in exactly the position in which it is placed. The plantar reflex is absent, likewise the patellar tendon-reflex. Sensibility (in its various kinds) of the right leg is normal. Patient complains of coldness of the limb.

The left leg is also paralysed and atrophied, but not to the same extent as the right. There is paralysis of the extensors of the pons and of the peronei; there is also some paresia of the extensors of the toes and of the hamstring muscles, but the muscles of the calf and the quadriceps extensor are little affected. There is paresis of the flexors of the thigh on the abdomen. The plant or reflex is absent. Patellar reflex present, sensibilities normal.

Measurements of Lower Extremities:

	Right.	Left.
Calf	10⅛ inch.	10¾ inch.
Mid-thigh ..	14 „	16 „

On striking the muscles of either lower extremity, fibrillar twitchings are seen.

Electric reactions.—The faradic current elicits no contraction whatever in any of the muscles of the right lower extremity. In the left limb the extensors of the foot and toes, the peronei, the muscles of the calf, the extensors of the thigh and the hamstring muscles, responded slightly to strong currents.

Galvanic reactions: Right leg.—The extensors brev. digit., the peronei, and the extensors of foot do not contract at all.

Calf muscles :—

KCC ..	..	15 cells ..	..	10° slight contr.
KOC ..	..	45 „ ..	..	25° (doubtful contr.)
ACC ..	..	10 „ ..	..	15° marked.
AC Tet.	..	25 „ ..	..	25°
AOC ..	..	20 „ ..	..	— (very painful.)

Left leg :—

Extens. long. digit. and tibialis antic.

KCC ..	..	20 cells ..	..	13°
AC Tet.	..	20 „ ..	..	15°

Extens. brev. digit.:

KCC ..	..	15 „ ..	..	10°
ACC ..	..	10 „ ..	..	10°
AC Tet.	..	25 „ ..	..	18°

Peronei:

KCC ..	..	15 „ ..	..	10°
ACC ..	..	10 „ ..	..	10°
AC Tet.	..	20 „ ..	..	18°

Calf muscles :—

KCC ..	..	15 „ ..	..	7°
ACC ..	..	10 „ ..	..	8°
AC Tet.	..	20 „ ..	..	15°

The upper extremities, muscles of neck and head appear perfectly normal on admission. All the internal organs appear healthy. There is no affection of either bladder or rectum.

During his further stay in the hospital he gradually grew worse, and the muscles of the upper extremity commenced to be affected, the shoulder arm and muscles being the first to show signs of paralysis and atrophy. I will briefly quote from the case-book the condition of the patient on Sept. 14, 1883. The patient lies in bed; can neither stand nor walk; can only assume the sitting posture with assistance, and he has great difficulty to remain in this posture. The right lower extremity is quite paralysed and atrophied, the joints flaccid. The left lower extremity is now almost completely paralysed, with the exception of the extensors of the leg on the thigh; the muscles of the left lower extremity are likewise flaccid; the patellar tendon-reflex on left side has now also disappeared. Sensibilities intact.

Upper extremities.—There is weakness of all the muscles, compared with their previous condition, but the shoulder and arm muscles are most affected. The flexors and extensors of

wrist and small muscles of hand act fairly well, and patient can perform all the movements with his fingers well. He can pronate and supinate freely with the left forearm, but is unable to do so fully on the right side; he can flex and extend the left forearm on the arm fairly well, but has slight difficulty in fully extending the right forearm. He is unable to raise either arm vertically from the side. He can raise the left arm to the horizontal position, but can only abduct the right arm about 6 inches from the side. He can place the left hand on the right shoulder, but can only with great difficulty place the right hand on the left shoulder. There is no loss of any sensibility in either upper extremity. No reflexes on striking the wrists or back of humerus.

The muscles of the right forearm and arm show slight tremors on movements; those of the left upper extremity do not.

The patient can execute all the movements of head and neck quite freely.

Electric Reactions of Muscles and Nerves of upper extremities:—

FARADIC CURRENT.

	RIGHT.	LEFT.
Flex. com. digit.	110 mm.	125 mm.
Dorsal inteross.	110 mm.	130 mm.
Biceps	80 mm.	110 mm.
Triceps	70 mm.	100 mm.

GALVANIC REACTIONS.

		RIGHT.	LEFT.
Flexor subl. digit. ..	KCC	15c. 17°	10c. 7°
	ACC	10c. 18°	10c. 10°
	AOC	30c. 25°	30c. 24°
	AC Tet.	30c. 28°	35 28°
Ext. com. digit. ..	KCC	15c. 18°	15c. 18°
	KOC	45c. 30°	40c. 30°
	ACC	10c. 15°	15c. 18°
	AOC	35c. 30°	30c. 30°
	AC Tet	35c. 30°	40c. 30°

ONE ELECTRODE ON ERB'S POINT AND THE OTHER ON STERNUM.

Right arm	KCC	15c.	20°
	AOC	20c.	20°
	ACC	25c.	20°
Left arm	KCC	15c.	20°
	AOC (marked)	20c.	22°
	ACC (faint)	25c.	20°

Direct Galvanization of Ulnar Nerve.

Right.	Left.
KCC 15c. 10°	10c. 10°
ACC 25c. 20°	20c. 15°
AOC 20c. 15°	15c. 15°

We notice therefore again marked degenerative reaction in the affected muscles.

The patient's condition altered very little for the next few months, and he left the Infirmary, Dec. 12th, 1883, but was re-admitted on Feb. 14th, 1884. It was found that the patient had now almost completely lost the power of his upper as well as his lower extremities. He now lies in bed perfectly helpless, is not able to raise himself in the least, and is unable to feed himself, or perform any other movements with his arms and hands. He is just able to flex and extend the fingers of both hands slightly; all the muscles of both upper extremities are markedly atrophied; there is, however, no "main en griffe." The muscles are flaccid. On striking the wrist, and also the back of arm, marked reflexes are seen.

Both lower extremities are completely paralysed. The muscles of the trunk also show now more atrophy and paralysis, especially the abdominal and pectorals. The muscles moving the neck and head, however, are normal. There is not any loss of sensibility in any portion of the body. Bladder and rectum act regularly. The tongue is clean, appetite good; there is slight abdominal distension. The movements of the chest walls are slight, the breathing is vesicular; there is no dyspnœa and no cough. Number of respirations 27 per minute. The heart's action is normal; the pulse 85, weak and compressible. The skin is moist, temp. 97°·5. The patient sleeps well, has no headache, and no cerebral symptoms. He remained in this condition up to June 15th, 1884, when it was noticed that the diaphragmatic and intercostal breathing became weaker, the respirations increased to 36 per minute; the patient's voice also became much weaker, and the expression of his face assumed an anxious appearance. Early on June 16th he had a severe epileptic convulsion, in which he died.

The post-mortem was made by Dr. Maguire, at the time

pathologist to the Manchester Infirmary. The thoracic and abdominal organs were found healthy, with the exception of the lungs, which were found œdematous and the seat of some emphysema. The brain and its membranes were normal; the brain on section showed many floodpoints; the sinuses did not contain an excessive amount of blood; the ventricles of the brain were not distended; cerebellum, pons and medulla appeared normal to the naked eye. The membrane of the spinal cord appeared healthy, and the cord itself was of a firm consistence throughout. Sections through the cord showed already to the naked eye changes in the anterior horns; these appeared depressed, highly pigmented, and in some few places minute spots of hæmorrhage were visible. The spinal roots and peripheric nerves appeared healthy. All voluntary muscles, with the exception of the muscle of the neck, had a pale appearance and were considerably atrophied. The spinal cord, posterior and anterior roots, a few spinal ganglia, many of the peripheric nerves and portions of muscles were kept for microscopic examination. Likewise the medulla, pons and portions of the cerebral cortex.

Microscopic Examination.—The muscles showed the usual changes; atrophy of the muscular fibres with loss of striation, multiplication of the muscle nuclei and cell-infiltration between the muscular fibres.

The small nerves in the muscles were found healthy.

The peripheric nerves, spinal roots and spinal ganglia showed no noteworthy changes. Some of the nerves, like the sciatic, seemed rather thinned; the several bundles of nerves were surrounded by fibrous tissue, containing a good many fat cells—and the sheath of the nerves showed fatty infiltration. The several nerves, however, showed normal relations, their axis-cylinders were well marked, and the medullary sheath appeared normal.

The spinal cord showed extensive and well-marked changes, chiefly in the anterior horns, and it may be said, without exaggeration, that throughout the greater length of the spinal cord, from the lumbar to the lower cervical region, not one normal ganglia cell could be found in the anterior horns.

In the lumbar region the affection was entirely confined to

the anterior horns; the ganglia cells were here found markedly atrophied, merely appearing as shining little specks; in the anterior grey matter there were also found granule cells, fatty detritus, and a few Deiter's cells were seen. The blood-vessels near the central canal showed a thickening of their inner and middle coat, and some peri-arterial cell-infiltration; small hæmorrhages were seen in the neighbourhood of the vessels.

The white matter and grey matter in the posterior horns showed increase of neuroglia, many Deiter's cells and blood-vessels, filled with blood-corpuscles and with their walls thickened.

In the dorsal region exactly the same changes were seen as in the lumbar region, with the addition of some sclerosis in the lateral columns, namely marked increase in the neuroglia, with atrophic changes in the nerve elements. The ganglia cells in Clarke's columns were less affected than the rest of the cells in the anterior horns. Sections from the dorsal region stained after Weigert, did not show the many small nerve-fibres seen in the healthy cord in this region. In the cervical region the changes were similar. In the lower part of the cervical region there was again lateral sclerosis. The changes in the ganglia cells in the anterior horns showed a less advanced condition of atrophy; some of the cells, though shrivelled, yet had a few atrophied outrunners; in some the nucleus even could be made out. The hæmorrhages near the central canal and the peri-vascular changes were better marked here than in the dorsal region. In the upper cervical region the lesion did not affect the lateral column, and was entirely confined again to the anterior horns. But here also the neuroglia throughout the white matter showed increase of Deiter's cells and peri-vascular cell-infiltration.

As the disease process in this case had been an ascending one, I requested Mr. A. Robinson, who is working in the pathological laboratory, to examine carefully the higher cervical region, medulla and pons, so as to study, if possible, the commencement of the pathological changes. Numerous sections were taken from the mid-cervical region upwards to the pons at the level of the root of the 6th cranial nerves,

and stained, some with carmine, some with osmic acid, and others with osmic acid and picrocarmine.

The changes Mr. Robinson describes as follows:—

The large ganglia cells of the anterior horns had almost entirely disappeared, a few only remaining at the anterior and inner portion of the anterior horns. These remaining cells were all more or less altered; some formed globular masses containing granules of a dark-brown substance, which completely shrouded the nucleus; others contained fewer of these dark-brown granules, evidently situated in the cell protoplasm between the nucleus and the cell wall. The processes of some of these latter cells were broken and irregular, and, after treatment with osmic acid, were found to contain masses of small black granules, while the processes of others were intact.

A few cells presented the appearance of a yellowish zone intervening between the nucleus and the cell wall; the whole cell having a glassy look. The neuroglia of the grey matter was very distinct. Deiter's cells were large and extremely numerous, but much smaller and finer in the grey matter than in the white columns to be afterwards described.

The blood-vessels in the grey matter were swollen and filled with red corpuscles. Their walls were thickened, the middle coat in many instances presenting the appearance of a clear hyaline band. And here and there in the anterior horns and grey commissure small hæmorrhages were found; two of somewhat larger size than the rest, just visible to the naked eye, were placed one on each side of the central canal.

The posterior horns presented no abnormal appearance.

White matter.—The neuroglia in the anterior and posterior white columns was normal; but in the lateral columns Deiter's cells were increased, both in number and size; their thick, anastomosing processes enclosed islets of nerve fibres, some of which were enlarged, and their axis cylinders were swollen. After treatment with osmic acid, dark granules were found external to the axis cylinders in the swollen fibres. The blood-vessels in the white columns were engorged, especially so in the lateral columns, where minute hæmorrhages were found between the nerve fibres. Ascending towards the decussation

of the pyramids, the nerve cells in the anterior horns became more numerous, and a few, at the inner and anterior portion of the anterior horns, appeared to be normal; but the majority presented some of the before-mentioned changes, and all stages were seen from the cells presenting only a yellow zone round the nucleus, and a generally glassy appearance, to the swollen globular cells, whose nuclei were hidden by a dense accumulation of dark-brown granules.

In the lateral columns the sclerotic changes became less and less marked, and could not be traced into the decussation.

The blood-vessels both of the grey and white matter were engorged, and small hæmorrhagic points were scattered in the grey and white substance, but specially in the former.

At the region of the decussation of the pyramids the morbid changes were less evident; but in the nucleus lateralis a few degenerated ganglion cells were found, while throughout the whole breadth of the cord the blood-vessels were engorged, and small hæmorrhagic points were scattered.

At a higher level (the commencement of the olivary nucleus), hæmorrhages, appearing to the naked eye as minute brown spots, were found in the central raphe, and smaller hæmorrhagic points were scattered irregularly over the section. The ganglion cells in the olivary nucleus, the nucleus gracilis and nucleus corneatus were intact, as were also the large cells of the hypoglossal nucleus; but the cells in the nucleus of the spinal accessory were loaded with dark-brown granules. No abnormal changes were visible in the remainder of the tissue of the medulla at this level.

Still higher, where the floor of the central canal opened out into the floor of the fourth ventricle, the same appearances were still presented; the nuclei of the hypoglossal nerves were healthy, but the cells in the vagal nuclei were loaded with dark-brown granules, and some of these cells had lost their processes and become globular. At this level, blood-vessels on one side of the medulla, running just below the nuclei of the vagus were greatly distended and engorged; at a slightly higher level this vessel was ruptured, and the effused blood had separated and destroyed the cells of the nucleus of the vagus on that side.

Above this level the abnormal appearances gradually ceased, and in the pons the nuclei of the 5th, 6th, and 7th nerves were healthy. The nucleus of the glossopharyngeal nerve was healthy, and in the pons the only abnormal appearance remaining was a dilatation of the small vessels and their engorgement with blood; but the hæmorrhages were no longer found.

The changes here described resemble very much those recorded by Cornil and Lépine,[1] especially as regards the vascular changes and hæmorrhages. From the fact, that these vascular changes were well marked in the highest cervical region, and also in the medulla, where as yet the changes in the ganglia cells were much less marked than in the lower cervical, dorsal, and lumbar regions—I am inclined to believe that the process is of a chronic inflammatory nature, with changes in the blood-vessels and hæmorrhage in their neighbourhood, and that the atrophy of the motor cells is secondary to the vascular lesions. That the vascular lesions often play the primary and most important part in many spinal diseases is seen from the recent observations on sclerosis in patches, diffuse spinal sclerosis, &c., where the vascular lesions are looked upon as the primary cause. The grey matter, being softer in structure and richer in blood supply, is even more likely to be affected by primary vascular changes, and the atrophy of the large ganglia cells would be easily explained.

There is only one point more in connection with this case to which I wish to draw attention. It was noticed during the latter part of the patient's illness that the so-called tendon-reflexes of the upper extremities were present, though there were no contractures, and it will be noticed that in the upper dorsal and lower and middle cervical region the spinal cord showed distinct lateral sclerosis. As the reflexes were noticed (though they had been looked for before) after the paralysis and atrophy of the limbs had set in, one cannot help thinking that they were secondary to the changes in the ganglia cells, and that this case, apart from the different clinical course, cannot be looked upon as a case of amyotrophic lateral sclerosis.

[1] 'Gaz. Méd. de Paris,' 1875, No. 11.

Case IV.

The next case I have to report is one which shows the difficulty of forming an accurate diagnosis. The patient when admitted had paralysis and atrophy of the lower extremities, and also of the muscles of both hands and forearms, the extensors being chiefly affected; there were also some bladder troubles. These symptoms came on within a few days, and were accompanied by pains in the lower extremities; the tendon-reflexes in the lower extremities were absent, those in the upper extremities were present. Soon after admission the patient had complete anæsthesia of the lower extremities and abdomen and chest, up to the third rib on the left side and sixth rib on the right side. Three weeks after admission the patient had a slight attack of pneumonia, with albuminuria. Though there was only the history of gonorrhœa with orchitis, the patient was submitted to an energetic antisyphilitic treatment, and recovered completely in a comparatively short time. I happened to see the patient a few days ago, and he was then in perfect health, being able to walk twelve to fifteen miles with ease. There is now no trace of either paralysis or atrophy, and the tendon-reflexes of the lower extremities have reappeared

The following is a brief outline of the history of the patient's illness.

Alfred K., fishmonger, æt. 45, was admitted into the Infirmary on Feb. 18, 1884.

The patient has lived in Manchester for the last fourteen months. Seven years ago he came to England from India, having been there twelve years in a regiment of Lancers. During his stay in India he had a bad attack of dysentery in 1871, but he never had ague; he has not had syphilis, but twenty-seven years ago had an attack of gonorrhœa, followed by the swelling of one testicle some months after; since then he never suffered from rash, sore throat, or any symptoms pointing to syphilis. He has been rather intemperate, and taken alcohol freely and regularly for twenty-five years. He has been married for twenty-four years; his wife had one miscarriage twenty-three years ago; after this she has had two children, of whom one died when six years old from some brain disease.

The patient's father died at the age of 84, his mother at 80. He has a brother and sister living who are healthy; two brothers and one sister died; the nature of their diseases he does not know.

Since his return from India the patient's health has been exceptionally good, and he has not suffered in any way.

Ten days before admission he noticed his legs giving way; his walking rapidly became worse, so that six days before admission, therefore in the course of four days, he was unable to walk at all; four days ago he noticed his hands becoming affected, and he was unable to hold anything in them. He was troubled at the same time with pain in his legs, and a distinct girdle pain round the abdomen; he was unable to control his bladder, and his bowels were confined; and after taking aperients he noticed that he had lost also some control over his sphincter.

Condition on Admission.—The patient lies in the recumbent posture, from which he can only rise with great difficulty; he is not able either to stand or walk, nor can he grasp or hold anything in his hands. There is marked atrophy of the lower extremities, and also of the hands and forearms; there is some slight œdema over dorsum of foot and lower end of leg on each side. There are several recent bruises on both legs, which the patient says were produced by repeated falls at the commencement of his illness. There are no enlarged glands to be felt anywhere, and the appearance of the face is healthy, and contrasts with the condition of the limbs. There is marked arcus senilis. There are no cerebral symptoms; the special sense-organs and cranial nerves are normal; the muscles of face and neck are unaffected.

Upper Extremities.—On the right side the shoulder and arm-muscles show considerable amount of power; the extensors of the wrist and finger are very weak; the flexors much less so. He can supinate and pronate, though to passive resistance these muscles appear weak; he cannot flex the index-finger or thumb, and is able to adduct the thumb and oppose it to the hand but slightly. There is marked atrophy of the thenar and hypothenar eminence, and of the muscles of forearm. The patient complains of pain in the shoulder, arms and hands.

No tendon-reflexes can be elicited. The left upper extremity is affected in a similar way; only to a still greater extent, the patient is unable to raise his left arm above his head; resistance to passive movements is weaker, and the paralysis both of the extensors of the wrist and of the fingers more marked. Tendon-reflexes are present on the left wrist and above elbow.

Lower Extremities.—The patient is unable to extend the foot or any of the toes on either side; he is unable to extend the knees or thighs, nor is he able to adduct or abduct either leg; he is, however, able to flex the knees and also the thighs, though there is not much power in the flexors, as seen by their resistance to passive movements. There is marked atrophy of both legs and thighs, and the muscles feel flabby. On the whole the left lower extremity is weaker than the right. The superficial and deep reflexes are absent. The patient complains of pain in his legs and thighs. Some of the paralysed muscles show fibrillar twitchings. The cremaster, abdominal and epigastric reflexes are absent. The presence of scapular reflex is doubtful. The patient has some loss of control over his bladder, and also over his rectum.

The examination of the thoracic and abdominal organs shows nothing abnormal. The urine has sp. gr. 1018, is faintly acid, contains neither sugar nor albumen.

Feb. 21.—The patient complains of numbness of his legs, and examination shows an almost complete anæsthesia of both lower extremities, and extending on the left side to the crest of ilium, both front and behind, and on the right side as far as umbilicus.

Feb. 22.—The anæsthesia remains stationary on the left side; on the right side it now reaches a line corresponding to lowest point of ensiform cartilage and passing in a semicircle right round the back to the middle line. Above the line of anæsthesia there is a small band of hyperæsthesia. There is no anæsthesia of the upper extremities. Sense for pain and for temperature appears normal in the anæsthetic region.

Feb. 23.—The anæsthesia has now reached on the right side a line corresponding to the fifth rib, and passing round to the middle line in the back. The anæsthesia on the left side has increased a little. The condition of the patient has not undergone any other changes.

The patient is now ordered mercurial unction and iodide of potassium, twenty grains per dose, three times daily; also a chlorate of potash gargle.

Feb. 24.—The upper limit of the anæsthesia on the right side has now reached the third rib. The condition is otherwards unchanged.

Feb. 28.—The anæsthesia is rather less; the patient noticed some slight improvement of his paralysis. He can move the toes of his right foot slightly and can extend the right wrist better. The left upper and lower extremity remain in the same condition.

From this date the patient's symptoms began to improve.

The electric reactions taken at different time showed degenerative reaction, as shown from the following data, observed on February 28th:—

Faradic Contractility of Muscles.

	Right.	Left.
Upper Extremity:		
Biceps	80 mm. ..	76 mm.
Triceps	70 mm. ..	65 mm.
Extensores digit. ..	20 mm. ..	15 mm.
Flexors of digits ..	40 mm. ..	30 mm.
Lower Extremity:		
Tibial antic. ..	60 mm. ..	60 mm.
Extensor digit. long.	35 mm. ..	30 mm.
Quadriceps	70 mm. ..	65 mm.

Galvanic Reactions, Direct Muscular.

	Right.	Left.
Upper Extremity:		
Extens. digit.	KCC - 15c.	25
	ACC - 10c.	15
Flexor digit.	KCC - 15c.	20c.
	ACC - 15c.	15c.
Lower Extremity:		
Tibial antic.	KCC 10	15
	ACC 10	10
	(strong contr.)	
Extens. long. digit. ..	KCC 15	15
	ACC 15	10
	(strong.)	

The other muscles were tried on other days with similar results.

On March 7th the patient's temperature, which up to now had always been nearly normal, suddenly rose to 100, and he

complained of pain in his right chest. Physical examination on March 8th showed dulness over the right base behind, and crepitation with every inspiration over the dull area.

On March 9th the temperature was 101°·2; the physical condition of the chest the same as before. The patient brought up some rusty sputum. The paralytic symptoms had remained stationary the last few days. The urine contains a small trace of albumen, sp. gr. 1023,—scanty.

After this attack of pneumonia the patient's condition rapidly improved. The lung symptoms had disappeared by March 23rd, the albumen a few days previously.

The anæsthesia had considerably receded, and was now (March 23rd) limited to the legs and thighs, but extending higher on the right than on the left side. The patient is able to extend his toes slightly; he can also flex the index-finger and thumb of right hand and slightly extend the right wrist. The left upper extremity is recovering much slower. Several of the muscles of the lower extremity, such as the vasti interni, the adductors of the thigh, and the quadriceps, act much better.

By May 31st, 1884, the patient had sufficiently gained power to be able to walk with the help of sticks, still dragging the legs, owing to the weakness of the extensors. The arms and hands have improved most markedly, and he can now grasp fairly well and perform even delicate movements with his fingers. The anæsthesia has completely disappeared. The superficial reflexes are now present, but the deep reflexes have disappeared. There are still the tendon-reflexes in the left upper extremity, but much less marked.

The iodide of potassium had been continued, and up to the present (May 31st), the patient had forty inunctions. For the last month he had been treated with weak galvanic currents.

On July 14th the patient was fit to be discharged, and he was sent to the Convalescent Hospital at Cheadle, where he remained for two months. He returned completely cured, and is now perfectly well. The patellar tendon-reflexes, which had remained absent for some time yet, have now reappeared.

As regards the nature of the lesion in this case, I am inclined to believe that it was diffuse central myelitis,

with some meningitis, probably of syphilitic nature. The symptoms correspond closely with those seen in two cases described by Déjérine,[1] and in a case given by Putnam.[2] These cases terminated fatally, and the lesion was chiefly an inflammation affecting the anterior and posterior grey matter. The anæsthesia being so distinctly limited, and being more marked on the right side, while the paralysis and atrophy were more pronounced on the left side (especially in the arm and hand), one might think of a syphilitic tumour; yet if this had been the case, and if the tumour were situated in the cervical region, we should have expected spastic paralysis of the lower extremities, and not atrophic paralysis. The continuity of the motor and sensory troubles from the lowest lumbar to the cervical region, strongly support the view, that a diffuse central myelitis affecting the grey matter was the cause of the symptoms observed. The implication of the bladder and rectum, apart from the exact linear limitation of the anæsthesia, show at once that the case was not one of peripheric multiple neuritis, or alcoholic paralysis.

[1] 'Revue de Médecine,' Jan. 1884.

[2] 'Journal of Nervous and Mental Diseases,' 1885.

(To be continued.)

AN EXPERIMENTAL ENQUIRY INTO THE NATURE OF THE OBJECTIVE CAUSE OF SENSATION.

BY JOHN B. HAYCRAFT, M.B., B.SC., F.R.S.E.

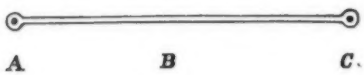
Professor of Physiology, Mason College, Birmingham.

THE present lecture, recently read before the Birmingham Philosophical Society, is an extension of a short communication to the Royal Society of Edinburgh,[1] and includes an account of some experiments conducted in my laboratory in the Mason College, together with a discussion of some general psychological problems.

If a stimulus, say a rapidly interrupted electrical current, be applied to the body for a definite period of time, it will of course produce a sensation; but that sensation will not coincide in time with the stimulus that produces it. In the first place, the sensation will not commence as soon as the stimulus is applied, and secondly, it will continue after the withdrawal of the stimulus. In the first part of this paper we shall discuss this non-coincidence in point of time between duration of the sensation and the stimulus.

The sensations have their seat in the brain, and the impressions require a definite time before they can reach this part of the body, situated as it is in so central a position.

FIG. 1.



Let A, Fig. 1, represent a particle (cell) at the surface of the body which is stimulated; B, a nerve passing from it towards a sensitive particle (cell) C in the brain. A definite time

[1] Proceedings R.S.E., 1883, p. 246. Abstracted in "BRAIN," April 1884, p. 141.

must elapse before A is excited by a stimulus, and the impulse thus set up has time to travel along the nerve B and throw into excitement the cell C. A nervous impulse travels no faster than some forty yards in a second, and from this factor alone—allowing three feet for the average length of a nerve path—the sensation will be delayed one-fortieth of a second.

But the sensation remains after the stimulus has been withdrawn. If I pin a small patch of red paper near the edge of this wheel, and then cause it to revolve, you will observe that the red patch moves round, then it appears to elongate, and finally, as the speed of rotation increases to some ten or fifteen revolutions per second, it is seen in the form of a complete red ring. You will remember, too, that in the firework known as the "Catherine Wheel," one part alone is alight, yet, when it revolves, one sees a ring of flame.

What is the explanation of this? At any given instant the patch of red or the coloured flame is at one spot only; how is it seen as if it were at all points of the circle in which it moves? This is very easily explained, for the sensation produced by the patch remains after the latter has moved away, and if we suppose that the patch starts from a certain point and revolves so rapidly that it comes back to that same point in a period of time less than the time that the sensation remains, we shall be sensible of a continuous ring.

This may be demonstrated in another and perhaps a more conclusive way. I will attach the patch of red to a steel spring, which can be caused to vibrate. I will now set the spring in such a manner that it will appear five times during each second above this screen, disappearing five times below and behind it. You are now conscious of a flickering sensation, but on altering the spring, so that it may vibrate ten times instead of five, the red patch appears continuously in front of the eye. The red object is, however, being continually withdrawn from view for periods of one-twentieth of a second. The sensation must, therefore, persist for this time.

In the case of hearing, Helmholtz found that when the "beats" follow one another at the rate of twenty or thirty a second, they cease to produce individual impressions, fusing

into a jarring grating, rough sound, which may be heard even when 130 beats affect the ear during the same interval.[1]

Physiologists tell us, that in the case of tactile sensibility no less than 1,400 impressions must stimulate the finger tip before they become fused. This statement is or is not correct, according to our interpretation of the word "fused." If it is meant that then, for the first time, they cease to produce individually a sensation, it certainly is not true. At most it is a very superficial description of what may with care be observed. Touch this revolving toothed wheel. On turning it very slowly, each little tooth will be felt in its turn, and will be recognised by a separate feeling of impact.

Increase somewhat the speed of rotation and it will be no longer possible to recognise each separate impact, but a sensation will be produced which we call "roughness." Rotate more rapidly, and the wheel will feel of a finer and finer roughness, until, when 1,400 teeth are brought in contact with the finger tip during the period of a second, it will feel like a rotating smooth wheel producing merely a shearing or displacement of a portion of the skin touched.

There are, then, *three* periods. In the first, we can distinguish in consciousness each individual impact and the gap which separates it from the next impression. In the second, they have lost their individual character and produce a sensation—"roughness." In the third this feeling changes into that of smoothness.

These periods are not sharply demarcated one from another, yet one may state approximately in one's own experience where one begins and the other ends. In my own case impacts as rapid as forty per second are recognised as distinct; forty to 1,500 produce roughness, and above that number a sensation results similar to that produced by a rotating smooth wheel. The number forty is probably too high. With very strained attention, I sometimes fancy I can distinguish as many impacts in a second. Perhaps it would be safer to put it down at thirty.

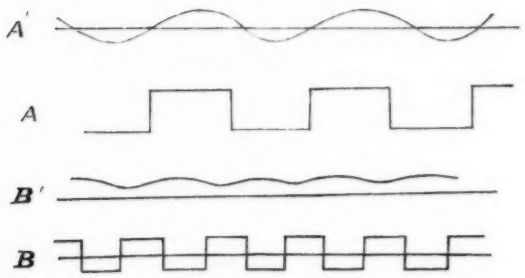
These numbers were determined by allowing a vibrating

[1] "The Sense of Tone, as a Physical Basis for the Theory of Music." Eng. Trans., p. 253. In English works Helmholtz has been generally misquoted. He never says that 130 beats may be heard individually in a second.

steel rod to strike the finger tip. Its pitch could be varied at will by weighting it or by altering its length, and could exactly be determined by arranging it so as to write on a smoked cylinder revolving at a known speed.

We can see, from the results of this experiment, striking analogies between the sense of touch and the senses of sight and hearing. In the case of the red object attached to the steel spring, in the case of the beats, which are intermittent sounds, and in the case of the revolving toothed wheel, we find that on increasing the frequency of the stimulus the sensations pass through three distinct stages. In each case the slowly intermitting stimuli are formulated separately in consciousness, each is followed by a period of rest, and then another is felt. Such slow periodic stimuli may be productive of great pleasure.

Fig. 2.



Slow beats may produce considerable artistic effect; the ticking of a watch and the "passes" of a hand over the skin may induce hypnotism. Slow intermittent stimuli are pleasurable and soothing—instance the rhythm of poetry and the rocking of a cradle.

Let the line A indicate the time of application of a slowly intermitting stimulus. The line A' shows the duration of the resulting sensation. The two lines are arranged in vertical series. When they rise above the abscissal line, they indicate respectively that at that point the stimulus is being applied or the sensation felt. On striking below the abscissal line, the stimulus is being withdrawn in A, and the sensation ceases to

be felt in A'. These lines indicate in a graphic way the condition of things in this first stage; two sensations being separated one from another by a period of rest—the curve descends below the abscissal line.

When, however, the frequency of the stimulation is increased, so that they are no longer individually felt, you obtain a continuous sensation, which varies periodically at first in its intensity, and indeed in the first part of this stage we may be conscious of this variation. This may be graphically represented (B and B'). The curve B represents the stimuli which are seen to follow one another more closely. In B' the sensations have not time to disappear before the result of the next stimulus follows on.

The sensations are now as unpleasant as those produced by slow intermission are pleasant in their nature Few things are more annoying than the flickering of a gas jet. Helmholtz has shown, that the cause of dissonance in music occurring when certain notes are sounded together is caused by the *rapid* beats they produce. When this wheel revolves so that thirty or forty teeth touch the finger tip, you remark that it feels rough, a term standing for a sensation or idea which is not of a pleasant kind. Thus we say "a rough fellow," meaning thereby a man whose activities are not of an agreeable nature. In the case of touch, and also of hearing, this second stage is much prolonged, being still of a disagreeable nature, although the sensation is absolutely continuous.

In the third stage the sensation is also continuous, and is not to be distinguished from a stimulus constantly applied.

Why stimuli, differing only in their frequency of application, should produce such different effects on the organism we cannot say. This question is, to a certain extent, out of the range of present experimental inquiry, and its consideration must therefore be postponed. It is enough that we can state this general psychological law, which applies to senses such as touch, sight, and hearing, where the sensations coincide pretty exactly in time with the stimuli which produce them, but not for the senses of temperature, taste, and smell, where the limits of the sensations are very diffuse. "Slowly intermitting stimuli are followed by slowly intermittent

sensations, which intermittence is pleasurable, provided the stimulus itself be not of a disagreeable nature. Increase the frequency, and the sensations become fused into a disagreeable rough sensation; and finally, in the third stage, they produce a continuous smooth sensation, not to be distinguished in quality from the same stimulus constantly applied." It is a curious fact, that in tactile sensibility the same sensation is produced, whether a single portion of the skin be stimulated in rapid succession, or a stimulus be rapidly applied to a series of sensory surfaces, one after the other. Roughness is produced, whether you place your finger against a revolving wheel, or draw the smooth edge of a knife, held vertically, along the front of the finger. In all cases it is combined with tickling, if the stimulation be very light. Hold a tuning-fork, set in vibration, against the lip; it tickles intolerably; draw a pin along the lip, and the same feeling is produced. Of course you are aware of the difference between the two, because the location is different. Both produce tickling. In one case this is associated with contact at one spot, in the other with contact shifting along the lip. The feeling of tickling and of roughness seems, then, to be produced whenever a series of nerve impulses, following one another in rapid succession, reach the sensorium, no matter whether they all came from one sensory point, or each one from a different sensory surface.

As no experiments, so far as I am aware, have been conducted upon the coincidence in time between the stimuli and sensations in the sense of temperature, I undertook a series, a portion of which I will now describe.

Touch this iron ball, which is a good conductor of heat, and you will be conscious at once of a sense of impact, but only after a very appreciable interval will you feel that it is cold. On withdrawing the hand the sensation of cold remains for some time. Obviously, the coincidence in time is not so exact in the sense of temperature as in touch. For more exact study of these phenomena I have used a very simple piece of apparatus. A long and slowly vibrating rod, 3ft. to 4ft. long, was fixed to an iron vice, and to its free end a glass bottle was attached. To this was fitted a cork, through which passed an

iron rod. The bottle was filled with a mixture of ice and salt, which cooled the rod in its whole length. The vibrating rod brought the cooled rod periodically upon the finger tip; it was held there for half a second, or long enough for it to be felt as a cold body, and then allowed to swing back. It was found that if the iron was brought periodically in contact with the finger, each time after the lapse of a second a continuous and uniform sensation of cold was produced; if after a second and a-half, each impact was associated with a *separate* sensation of cold. The sensation remains for more than a second after withdrawal of the stimulus, but not for so long as a second and a-half. As will be presently shown, the same results are not obtained when other parts of the body are stimulated.

Sensations of cold and heat, as well as of impact, result from stimuli applied to the surface of the skin. Remove this, and the subjacent bones and muscles are found insensible to these stimuli. Now the skin is a large and extensive tissue, and microscopical sections taken from various parts show considerable differences. Some parts are more richly supplied with nerves than others, and these are regions where sensation is acute. In many places the horny outer layer, into which the nerves do not pass, is very thick, and it may be developed into protecting structures, such as nails and hairs. The experiments on tactile and thermal sensibilities, recorded in this paper, have been made with the skin of the finger tip. Let us extend the enquiry, and examine other parts of the skin. It is well known that all parts of this tissue are not equally sensitive to touch. The skin of the finger tip and the front of the hand can be stimulated by the impact of a lighter body than will affect the skin of the back of the hand. Again, the skin of the front of the arm is more sensitive than that of the dorsal surface, and still more so than the skin covering the shoulders. Together with this difference in actual sensibility, the brain is unable to localise impacts which affect the less sensitive parts so exactly as those which affect the more sensitive parts. If the points of a pair of compasses, less than one millimetre apart, touch the finger tip, they may be distinguished one from the other, but over the skin of the

back they may be held over an inch apart, and yet give rise to only one impression. This difference, not to be discussed here, is due (partially, no doubt) to the arrangements of the peripheral nerves. What I propose to discuss is, whether the non-coincidence in time between the stimulus and the sensations varies with the sensibility and powers of localisation of the surface.

If a rod, vibrating some twenty times a second, be held to the finger tip or lips, sensations of distinct impacts may be felt. Allow the rod to vibrate upon a surface less sensitive, say the skin over the sternum, and the impacts are individualised almost as before. I should mention that inasmuch as the skin is less sensitive, the amplitude of the vibration and force of the impacts must be increased. There is little difference then, in this respect between the more sensitive and less sensitive parts. On experimenting with the toothed wheel applied to the sternum, it is impossible to obtain the finely rough sensations with rapid rotation which could be felt by the finger tip. This is probably due to the less sensitive nature of the surface, and the impossibility of pressing the wheel upon the skin in order to compensate for this without producing at the same time injury to the surface. We see, then, that in less sensitive parts the sensation coincides in time almost as exactly with an applied stimulus as in the case of the more sensitive parts, whereas the space localisations are so different.

Let us now extend our observations on the sense of temperature to other parts of the body. Apply after intervals of a second a good conductor—say an iron ball—to the skin of the bare arm; distinct sensations will be recognised on each application, whereas a continuous and unbroken sensation is produced on touching the ball in the same manner with the finger tip. This is not due to the fact that the arm is usually protected, and in consequence might be conceived as less inured to cold, for the same obtains with the skin covering the forehead and lips. The difference is partly due to variations in the thickness of the epidermis—a bad conductor—which separates the body touched from the nerves situated in the lower layers of the skin. The corneous fingers of a working-

man allow but slow conduction and a sensation is perceived only after a lapse of two or perhaps three seconds.

In our study of the senses of hearing, sight, and touch, I have shown that we are able to perceive twenty or thirty sensations in a second, and, but one, or at most two, sensations of cold or heat may be felt. We find that the sensations of taste and smell, like those of temperature, spread over a longer period of time, and are not sharply limited in duration.

Herbert Spencer, in his "Principles of Psychology" (vol. i., p. 169), calls attention to this difference, distinguishing between peripherally initiated feelings caused by internal disturbances—some of which he says are extremely indefinite, and few or none definite in a high degree—and feelings caused by external disturbances which are mostly related quite closely alike by co-existence and sequence. He illustrates this by the fact, that our states of consciousness in connection with vision and hearing are more sharply limited in time and space than those in connection with smell and taste, and, still more, hunger.

Now, discarding the fact that when considered developmentally, the retina at any rate is far more internal than the mouth or nose, the former being really a portion of the brain, the latter puckerings in of the surface, I would suggest that the all-important factor producing this difference is not anything in the brain, nor in the nature of the feelings themselves, as Herbert Spencer seems to me to indicate, but in the nature and arrangements of the end organs. If the point of a pin impinges upon the finger tip, the epithelium is depressed, and at the same time the nerves of tactile sensibility are stimulated, and on withdrawing the pin they are in a condition of rest. Also in the ear, the sound vibrations travelling rapidly into the internal ear cause the structures there (the basilar membrane and rods of Corti) to vibrate, and —as we are aware from our knowledge of the action of one vibrating body upon another—they do this very rapidly.

Far otherwise with the senses of smell and taste. When odorous particles pass into the olfactory or upper part of the nasal cavity—in which the nerves of smell are placed—it is by diffusion from the lower or respiratory part of the nose. If

the breath be held, and a piece of incense paper be burnt in front of the face, some time may elapse before the scent is perceived, because the odorous particles have in fact to diffuse into a closed sac, slowly increasing in numbers. If, on the other hand, the experimenter "sniffs" the air, the stimulus will be more rapidly perceived, because a large number of odorous particles are carried rapidly through the lower chamber of the nose, inducing out-currents from the upper chamber, which consequently becomes immediately filled by these. In like manner, the closed sac has to get rid of odorous particles from within it by this same slow process of diffusion, before the odour ceases to be felt. The application and removal of the stimulus is then a gradual process. The feeling produced is therefore gradual in coming on and slowly passes off.

In the case of the sense of taste, the same holds true. Substances held in solution are alone tasted; the tongue is covered with a layer of mucin derived from mucous and salivary glands, and the nerves are not superficial but embedded in the epithelial covering. It will be easily understood that in this case also the accession of a sensation must, from the nature of the stimulus, and the position of the end-organ, be gradual in its production and slow in passing off, and therefore not strictly limited in time. The watery solution has to mix in the first place with the mucin covering the tongue, before it can reach the end-organs situated in the epithelium.

In the case of hunger again, the limitations in time are due entirely to a condition of things other than mental. The fulness of the alimentary canal is associated with a feeling of comfort, and when no food is present there with a feeling of hunger; and as there is every conceivable transition between a condition of full stomach and an empty one, so the passage of the one sensation into the other must pass through innumerable transition states.

If it be needed, another example may be mentioned in the case of the cold body applied to the horny tip of the finger, and to the thin skin covering the sides. The nerve-endings are stimulated by the addition or withdrawal of heat from the

nerves of the skin. This is gradual, and does not correspond to the application of the cold body to the surface because of the horny epithelial covering. Where this covering is thin, the limitation in time of the sensation is more definite than where it is thick; and could we apply the cold body directly to the nerve end-organ, the limits would then be very sharply defined. Cover the hand with a glove, and the limits would be very ill-defined indeed.

Sufficient evidence has, I think, been adduced to show that where the limits of a sensation are not well defined in time, we may conclude that this is not due to anything in the nature of the sensorium, but depends upon the way the external energy is changed into nerve energy in the terminal end-organ.

Let me define a sensation as the result of a transformation of the energy travelling along a nerve of sensation from without, into the energy manifested by the nerve cell to which it passes. We have, I insist, no reason to doubt, that if that nerve energy travelled twenty times a second along a nerve of smell, of taste, hearing, or of sight, we should be conscious of twenty separate sensations in each case.

That such a transmission is impossible in every case we know, but it is due to the fact, that in these cases the nerve cannot be stimulated from without so frequently.

A theory advanced, that quality in sensation depends for its objective cause upon the "frequency" of the vibration of the stimulus which produces it.

The air may be caused to vibrate at infinitely long or infinitely short periods, and at all intervening rates. If I pull this long steel band which is fixed to an iron vice and then let it go, it will vibrate and set the air in motion. It is now vibrating some ten times a second, but, although the amplitude is very great, you hear no sound. Shorten the band, increasing therefore its frequency of vibration, and you hear a low deeply-pitched note. Continue to shorten, and the note becomes higher, and higher, and at last you can hear nothing at all. We see that here, at any rate, the different sensations you were conscious of depended upon the frequency of vibra-

tion of the air set in motion by the vibrating steel band. The steel band—and the same applies to other sounding bodies—not only vibrates as a whole, but also in parts, so that the air is moving in rather a complex manner. We have the movement of the air corresponding to the movement of the band, as a whole producing what is called the fundamental tone; and in addition, movements corresponding to vibrations of parts of the band, and producing the "harmonic tones."

Now, the sensory quality which distinguishes one instrument from another—the difference say in the "sound" of a string stretched upon the sounding-box of a guitar, and another attached to that of a violin—depends upon a difference which these boxes produce in the number and strength of these harmonics; upon, in fact, the intensification of certain frequencies. The multitudinous sensations of the Concert Hall or Opera are produced by immense numbers of little waves, varying infinitely in periodicity, falling upon and stimulating the ear.

Much the same may be said of sight. A something called "Ether" may be thrown into vibrations, and these cause the sensations light and colour when they fall upon the retina. When a ray of light is passed through a prism, the vibrations of which it is composed are separated out in a scale called the spectrum. At one end, in the region of the ultra-red, we have slow vibrations. Like the very slow vibrations of the steel band, they produce no sensation. Higher in the scale where the rapidity is greater (some 481 billions per second) a sensation called red is produced. As we pass higher in the scale, the sensation changes into orange, then into yellow, green, blue, and last of all violet. Where still more rapid vibrations are found, namely in the region ultra-violet, no sensation—again the analogy with the steel band is seen—is produced. We see here again, that it is frequency or rapidity of vibration which determines the quality of the produced sensation.

For the last few years I have held as probable, that much the same holds for the senses of taste and smell, believing that just as a certain vibration will produce, say, a sensation of colour or of sound, so the periodicity of the vibrating particle given off from the scented rose, or of the molecule in solution,

will determine the sensation of smell or taste produced. This is now removed from the field of mere speculation, and one may look forward to a time, perhaps not far distant, when in a more advanced state of molecular physics one may be able actually to determine the rate of vibration of even complex substances; a time when the arrangement of a bouquet or menu may be as scientific as thorough-bass.

Professor William Ramsay, in a very valuable communication to "Nature" (June 22nd, 1882), has brought forward, I think, some very important facts as to the objective cause of smell. He finds that gases of very small molecular weight, and therefore of high pitch, are incapable, like the ultra-violet rays and the very rapid vibrations of the steel band, of producing a sensation. All the simple gases, and many of the compound ones, are odourless; in fact, a gas must have a molecular weight fifteen times as great as that of hydrogen, in order that it may be smelt. He has studied certain chemical series, for example hydrocarbons, such as the paraffins and olefines, which increase regularly in molecular weight. The lightest have no smell, but passing up the series odours may be perceived, which vary in quality, and increase as a rule in strength. There are many other points in this paper which show analogies between smell on the one hand, and sight and hearing on the other. It seems difficult, however, to find examples of very heavy gases which, like the ultra-red vibrations, produce no sensation at all.

I have myself been working at the sense of taste, and have been already able to arrange many familiar tastes in a scale or series, associating them in each case with definite molecular vibrations. The subject is not, however, so complete as I should wish, and I have postponed its publication.

I have been also able to arrive at similar conclusions in respect to touch. Let me ask you, Mr. President, once more to touch this revolving toothed wheel. I turn it very slowly, and you feel each separate tooth. Increase its rapidity they fuse into a sense of "roughness," and as I continue to increase the speed you pass through every possible degree of sensation from a coarse to a fine roughness, and finally, it is rough no more. We have here, in fact, quality of sensation depending

upon frequency of impact. There are a hundred grades of sensation intermediate between a very coarse and a very fine roughness. These are not grades of quantity, but of quality.

It is true, certainly, that there may be a difference in quantity, but that is because on rapidly rotating the wheel we cannot *press* the finger against it without fear of injury. It is equally true with many sound instruments. On increasing the revolutions of a syren the music is at first low and voluminous, then it becomes higher and less voluminous, but more intense. The higher notes of a piano are weaker than the lower ones.

A moment's consideration will suffice to show, that this "roughness" is as much a sensation, with qualitative variations, as taste and smell. It is incorrect to say that it is a sensation *of* intermittent stimulation, although it is a sensation *produced by* intermittent stimulation, which is quite another thing. From our very earliest infancy the objective cause of the sensation has been known to us, yet at first it must have been gained entirely by experience, which without the assistance of the eye would have been very difficult. We can no more be said to be conscious of 1000 impacts in a second of a toothed wheel, than of 256 vibrations of a wire when the lower C on the piano is sounded. In both cases we have definite sensations, and in both cases we have been able to associate these with their objective causes. A practised musician on hearing a note sounded might name it, and tell the period of the string that produced it. After long experience with the sense of touch, after careful attention to the sensations, after careful experiment conducted to find the exact frequency of impact producing these, it would also be possible to say of a given sensation, that it is produced by so many impacts per second.

It may further be objected, that an intermittent impact is not the same as a vibrating stimulus. In one case the skin is stimulated for a certain time, and then it is stimulated no longer, whereas when a sonorous vibration stimulates the organ of Corti it is thrown into periodic movement, alternating in direction, and without a break in its continuity. This difference is more apparent than real. A child upon a swing may be kept in motion in either of two ways. In the first case,

by a force applied, say by means of the hand, which shall adapt itself in every way to the pendulum action of the swing, varying in the direction of its application and increasing in amount as the lowest point is reached. This represents one vibration producing another. The vibrating arm causes the swing to vibrate. Or secondly, the swing might be set or kept in motion by short pushes, synchronous with the period of the swing. This, of course, represents an intermittent force producing a vibration. We see, then, that although the toothed wheel is applied periodically, and is not in itself a vibration, it may produce a vibration of the skin. Indeed, as the skin has "mass," this must be the case. In all cases, it is the vibration of the sensory surface which is transformed into nerve impulse, it matters not how this is produced. It need only finally be added that it is possible to stimulate the skin with true mechanical vibrations, which produce the same effect on the nervous system as the toothed wheel. Instead of the ordinary toothed wheel, use a grooved wheel, the border being regularly curved. Apply the finger to its border, or place a vertical metal spring, fixed at one end to the vice, between it and the finger, so that on revolving it pushes the spring alternately forwards and backwards. In this case the motion will be a true vibration. We have then in touch, as in sight, hearing, taste, and smell, not only quantitative variations, but in addition a *scale*, each part of which is quantitatively different from the rest.

There is yet another sense, that of temperature. Its study in this connection is most interesting.

Lord Bacon anticipated some of the results of the Dynamical Theory when he stated his belief, that heat was a kind of motion or agitation of the particles of matter. The ultimate particles of gases, liquids, and solids are probably in constant periodic movement, and these movements may be transformed into nerve impulses. As in the other senses, certain specific structures are necessary for this transformation; they are found in the skin. Bring a live coal near the hand; its particles are in a state of great agitation; it induces similar motions in the skin, and these are transformed into nerve impulses, which, passing to the brain, produce a sensation—

"heat." If we stop to consider for a moment the various heat sensations of which we are conscious, we are struck with this very curious fact, that there is an entire absence of *quality* in this sensation. We may have in the other senses different qualities and kinds of sensation, and these may, in addition, vary in amount or quantity. There is nothing in the sense of temperature which corresponds with pitch in music, or colour in sight. We have "more heat" or "less heat," but it is always of the same kind. We cannot distinguish the heat of a hot potato from that of a piece of iron at the same temperature.

We must not be deceived by the terms "hot" and "cold." These are not qualities, but two quantities relative to the body temperature. In the same way we have light and darkness, sound and silence. Just as darkness may be less light, so cold is less heat—indeed the darkness, by common experience, may after a time become relatively light, and the cold may become relatively warm when afterwards compared with super-added sensations. Pass from a light into a dark room; you can see nothing. In a few minutes you become sensible of light. Plunge your hand into tepid water after warming it in front of the fire, and it feels cold. Now place the hand in ice-cold water, and then into the tepid fluid, and the latter feels quite warm.

There is, then, nothing of the nature of a qualitative difference in our sense of temperature, and curiously enough there is nothing which, according to our theory for the production of quality in other senses, would produce quality in this.

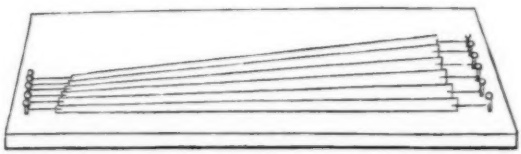
Physicists tell us, that when a body gains in temperature its molecules continue to vibrate at the *same rate or frequency*, increasing only in *amplitude*. When the skin is heated, from whatever source, its molecules do not vibrate either more quickly or more slowly than before. We have, then, objectively no difference in frequency of vibration, and subjectively no difference in quality.

The experiments of Kirchoff and Balfour Stewart tend to show, that at very high temperatures certain "partial" vibrations become more pronounced, but before these temperatures

could be reached the skin would be entirely charred. These temperatures are therefore outside the range of our enquiry.

Returning once more to the study of tactile sensibility, the usefulness of a sensation will depend upon two things. In the first place, it will depend on the extent of the scale of quality which is present, and in the second upon the smallness of the difference of quality that we are able to appreciate. In sound we have some eight or nine octaves, which can produce sensations; and towards the middle of the scale a practised musician is said to be able to distinguish two notes one-sixtieth of a tone apart. In sight we have barely an octave, yet within this small scale we are very sensitive to minute intervals. How about the sense of touch? Taking twenty-five for the lowest number in the sense of roughness, and 1,500 as the highest, we have nearly six octaves; more than in sight, but not so many as in sound.

FIG. 3.



Within this scale what differences can we discern? To investigate this question I have constructed the following instrument, which may be called the "touch-board."

It consists of a series of steel bands radiating from a centre, and bounded by two concentric arcs. These are fastened by their edges to a board, and are kept "taut" by wires passing to metal pins. On the right-hand side the interval between the bands is one centimetre, but to the left it is only half a centimetre. On drawing the forefingers of the two hands across the bands with the same velocity and placed at both extremities, the right-hand finger will be stimulated twice as often during the same time as the left, giving a difference which may be compared with the musical octave. Intervening points—not shown in the cut—are placed on the board, corresponding to thirds, fourths, &c., down to a quarter of a

tone. In practising with this instrument the operator must be blindfold, and another person should be present in order to reverse the position of the touch-board. This is absolutely necessary, for the imagination has much power in this kind of experimentation. In my own case it is perfectly easy, without a previous experimental course, to distinguish the intervals down to a semitone. I do not think I am more sensitive to roughness—differences—than others who use their fingers. No doubt those engaged in many trades, where there is constant testing of the roughness of materials, could distinguish smaller intervals. In the case of the blind, too, this sense is of great importance. I have not yet tried a blind person with the touch-board, but I should expect, that in this case very small intervals indeed could be detected.

In music, we find that small intervals are not distinguished so readily in some parts of the scale as in others. Thus towards the extreme upper limit, one may be unable to distinguish two notes a semitone apart. It is the same with touch. If the hands are drawn very rapidly across the board, the smaller interval cannot be made out. Towards the extreme upper limit I am able, however, to distinguish an interval of a third.

The sense of roughness, to which so little attention has been given, is yet of great importance. It has qualitative variations, almost as great as the musical scale, and the sensations are definite, and may be distinguished fairly sharply one from another. It is by this sense of roughness that we learn much of the nature of the external universe. By it we distinguish the roughened border of a file, the granularity of a surface, and the texture of a fabric. Its study has not engrossed the minds of physiologists and psychologists, because of the prevalent idea that it is merely an intermittent sensation, resulting from intermittent stimulation. This we have shown not to be the case.

Let us turn to the larger question, namely, that quality of sensation is objectively determined by frequency of stimulation. In the senses of sight and hearing this is undoubtedly the case. I mentioned that strong evidence has lately been brought forward in favour of smell, and some experiments of my own on taste tend towards the same result. In touch, too, we have

a curious example of a sense where subjective quality evidently depends upon objective frequency of impact. A curious negative proof is furnished in the case of temperature. Here we cannot be said to have any subjective quality at all—merely a sense of quantity. On studying objective temperature we find that the molecules of bodies, when heated to different temperatures, do not vibrate at different rates, but only at different amplitudes. Here we have no variations in objective frequency, and no variations in subjective quality.

SENSATION AND MOVEMENT.

BY CH. FÉRÉ, M.D.,

Assistant-Physician at the Salpêtrière, Paris.

In a series of communications made this year to the Société de Biologie and to the Société de Psychologie Physiologique of Paris, I endeavoured to show that peripheral excitations and psychical operations are accompanied with motor phenomena which, under favourable experimental conditions, may be demonstrated even by rough methods. These facts, which give a material demonstration of some views expressed by modern psychologists, may be found worthy of being brought together here in a condensed form.

The naturalist Péron had (1800–1804) found that the aborigines of New Holland, and the Malays of the island Timor, displayed a much smaller power of muscular effort than the French sailors with whom they were compared. Dr. Manouvrier[1] made the same remark concerning the majority of the savage tribes exhibited in the Jardin d'Acclimatation. I have also observed in a certain number of negroes that the muscular expression on the dynamometer is inferior to that displayed by most Europeans.

Broca had undertaken, during the latter part of his life, researches which, though not found mentioned in his published works, have formed the starting-point of our own researches. They dealt with the strength, as tested on the dynamometer, of persons belonging to various classes of society. The result was that the pressure produced by the effort of closing the fingers is less among workmen whose profession is solely manual, than among those who spend less muscular force, but whose intelligence is brought into use; and that it is greater still among people belonging to the liberal professions, under

[1] "La Fonction psychomotrice;" 'Revue Philosophique,' June, 1884.

similar conditions of age. The influence of body-height is not considerable. A certain number of experiments show, that among women, the greatest effect of a momentary effort is related to the greatest intellectual activity.

Dr. Manouvrier has made dynamometric researches on subjects who do not professionally exercise their muscles, and thinks that the energy of the contraction may be related to the size of the brain; but there is no proof of this assertion. We may assume, however, that *the energy of the momentary effort corresponds with the habitual exercise of the intellectual functions.*

It may be objected that it is impossible to determine the part played by differences of alimentation and hygiene in the production of differences in the energy of voluntary movement; and moreover, that it is imprudent, in such matters, to frame definite conclusions from insufficient statistics. It was therefore necessary to bring forward new facts in support of this influence of intellectual work.

It is generally known that under the influence of certain physiological states, such as anger, or of pathological conditions, such as maniacal excitement, muscular efforts acquire an extraordinary vigour; but this exaggeration has never been regularly measured. Dr. Manouvrier had already remarked that the fact alone of experimenting in public increases the strength of the movements; this is true, and we may add, that the experiment made before a person of the opposite sex exaggerates it still further. This excito-motor influence is, I believe, proportionate to the excitability of the sexual feelings, and deserves to be studied more fully from the point of view of selection.

These facts are interesting, but insufficient to explain the part played by psychical action, which must be put into evidence by another method. It is to be noticed at the outset that one obtains fairly constant dynamometric results on the same individual and with the same instrument, and that exercise has but little influence. I have made upon myself many thousand experiments, divided into series at several months' interval, and have noticed but a very slight and gradual increase. It was important to settle this point before

investigating the daily alterations due to the influences we have to study.

Under the influence of intellectual work, the dynamometric readings show an increase of one-sixth, one-fifth, or even one-fourth, according to the kind of work, and according to the more or less steady attention given to it. In many explorations I have observed a tendency to an equalisation of both hands—*i.e.* that the left hand (which is weaker than the right by 10 kilos nearly) often gains more rapidly than the right under the influence of the psychical excitation due to the intellectual work. This increase is momentary, and generally disappears a few minutes after the stimulus has been removed. These experiments, which show that *at the moment of intellectual activity there is a momentary increase of voluntary power of movement*, strengthen our first conclusion, and explain the fact already observed, that dynamometric measurements taken immediately after rest, generally point to a less degree of power for muscular effort than those made later, after the psychical functions have been exercised.

In order to appreciate the dynamogenic value of psychical functions, we must study only such operations as are accompanied with the least possible movement, such as hearing a speech, silent reading, &c.; for the act of speaking and writing introduce a new motor element into the experiment.

It is not only under the influence of an intellectual effort that the dynamometric power is augmented; the exercise of a limb different from that under observation may produce an analogous effect, though less markedly. If, for instance, one makes with the foot the movements necessary to drive a wheel with a pedal, it is observed that in a short time the dynamometric power of the corresponding hand, then that of the other, is augmented by one-sixth or more. The exercise of speech may produce the same effects, and its influence on the psychical excitation is well marked in certain nervous individuals, who become, as it were, intoxicated by speaking; thus we see that the most excito-motor psychical acts are those which are accompanied with phonetic or written signs, or expressive movements.

On the other hand, if one makes during one or two minutes a series of movements of flexion with the hand to be tested, an

augmentation of the force of the dynamometric pression will be observed. This fact is in accordance with the remark made by most experimenters, that the second squeeze on the dynamometer is usually stronger than the first. The instinctive habit of stretching the limbs has for its effect an awakening of the muscular sense. These experiments show, that when a limb is put into action the movement determines in the cerebral centre of this limb dynamogenic action, which spreads to the neighbouring centres. We may perhaps infer therefrom, that the paralysis of the same centre would be capable of exercising an inhibitory action; and thus might be explained the fact, that even when no bilateral descending degeneration is present, every destructive lesion in the motor region produces a weakening in the four limbs. Brown-Séquard has insisted upon this view more than once.

Finally, we may say, that passive movements produce the same motor excitation as active; the excitation appears to be in the former case even more intense. This result acquires considerable importance when taken along with the following facts. The history of spasmodic epidemics shows, that among individuals sensitive to all dynamogenic and inhibitory agencies, the sight of a rhythmical movement may excite the production of this movement. This phenomenon of psycho-motor induction may be sporadic, as Prof. Ch. Richet has shown. If the subject be made to look attentively at the movements of flexion which we make with our hand, after a few minutes he says that he has the sensation of the same movement in his hand, though it is quite motionless; and after a little while, his hand begins to execute, irresistibly, rhythmical movements of flexion. Now, if instead of going so far, we stop when the subject begins to have the sensation only of the movement, when the latter is in the nascent stage, we place a dynamometer in his hand, it is found that the force of pressure is augmented by one-third or one-half. These facts seem to us to show, that *the energy of a movement corresponds with the intensity of its mental representation.* This deduction corresponds with the views of psychologists, who state that the idea of a movement is already the beginning of the movement. Hence it follows, that whenever the idea is

sufficiently vivid, the action follows necessarily. This is an important point in explaining irresistible impulses, when the act is the inevitable consequence of the persistence of the idea. On the other hand, we may say that an idea really exists only when it is followed by an act which is the only proof of its intensity. We must distinguish between weak or static ideas, and strong or dynamic ideas. The excito-motor influence of passive movements is precisely due to the fact, that they provoke a recal of their motor images.

This influence of passive movements is taken advantage of in the treatment of certain cases of loss of power. When single muscles have been excited, either by massage or by electricity, the function of each muscle may be re-established by an action on the psycho-motor centre; but the function of the limb may nevertheless remain in abeyance, owing to the absence of co-ordinating impulses; the latter are sometimes quickly restored by the exercise of artificial movements, which complete the re-education of the centres.

The central effect of peripheral excitations may be placed into evidence by other experimental facts observed in persons subject to hypnotism, and upon whom dynamogenic agencies have a more definite influence. If on one of these subjects, when awake, a muscle be excited by massage, it becomes rapidly tetanised; the repetition of a passive movement which brings the same muscle into play, produces the same effect; voluntary action has the same result: the identity of this result shows the fundamental identity of the process. When a muscle is excited by some means or other, its motor centre is acted upon by the revival of a motor image. If the excitation is intense, tetanisation spreads to the associated muscles, and even to all the muscles of the limb, and when a fresh excitation is made on an antagonistic muscle, an epileptiform convulsion is often produced, which may bring about loss of consciousness, and become generalised through the whole body. This succession of phenomena can be explained only by an excitation of the higher centres, which is produced the more readily the greater the psycho-motor excitability of the subject.

I have, up to this point, been endeavouring to bring into

light the influence of psychical stimulation, whatever be its origin, on the energy of voluntary movements, and particularly on the momentary effort. The sustained effort, *i.e.* the resistance to fatigue proceeding from a kind of automatism, is different, and deserves a separate study. I may mention that if psychical activity has an influence on the energy of voluntary movements, the latter may also influence the former. Some people instinctively begin to walk when they wish to concentrate their thoughts, and the effect of movement is sometimes sufficiently marked to be appreciated by them; an increase of the power of recollection has more particularly been observed.

We may conclude, that each time one of the cerebral centres enters into action, it determines an excitation of the whole by a process which has not yet been determined. This statement is important from the point of view of hygiene and education, as showing the use of bringing into play as many functions as possible in developing all and each particular function.

Most of the preceding conclusions have been derived from experiments made upon myself, but certain of these results required further differentiation. Hence, I resorted to subjects presenting a morbid excitability, and so to speak, an enlargement of dynamic manifestations. Hysterical individuals, and particularly those liable to hypnotism, are particularly good subjects, and are for the purposes of the experimental psychologist what frogs are to the physiologist. Here is a series of experiments made on such a subject.

The patient was one of Professor Charcot's hystero-epileptics. She has double anæsthesia, chiefly on the left; the dynamometer shows an average of 23 kilos on the right, and 15 on the left. These are low figures, considering her robust appearance; but we know that hysterics usually have a weakness of the muscles, chiefly on the anæsthetic side. The experiments were made at various intervals, and always after a preliminary dynamometric exploration, which showed that her average state was not modified. The constancy of the results eliminates every fallacy arising from the action of the patient's will. The following numbers are clear enough.

	RIGHT.	LEFT.
(*a*) Normal dynamometric strength ..	23 ..	15
(*b*) After 20 passive movements of flexion of the right fingers	.. 41 ..	14
(*c*) After 20 active movements ..	.. 45 ..	20
(*d*) After having counted up to 45 ..	.. 44 ..	24
(*e*) After mental effort of adding 366 and 374	.. 41 ..	36

These numbers show that when intellect comes into play, dynamogenic action tends to be diffused to the opposite side; and that in the intellectual effort there is a certain tendency to the equilibration of the strength of both hands.

	RIGHT.	LEFT.
(*f*) After 20 movements of the right leg (voluntary flexion of the two segments) ..	46 ..	28

This experiment shows, that the exercise of a leg exerts its chief dynamogenic action on the arm of the same side; this action is even sometimes limited to that side. The synergy of the two limbs on the same side is still further shown by the fact, that when an effort is made with the right hand, it is in the right leg, and particularly in the triceps, that a sensation of contraction is experienced, and this contraction sometimes becomes real.

We may perhaps legitimately conclude from this fact, that the exercise of one limb dynamogenises the other by calling forth, in its psychical centre, motor representations which gradually become diffused to the opposite side. We may give numbers which will confirm what we have been saying, that the development of motor strength is under the influence of the mental representation of the movement:

(*g*) The right hand of the patient is extended on the knee, the experimenter places his own hand near, fixes upon it the attention of the subject and repeats 20 times the movement of flexion of the fingers; at this moment, the dynamometric strength of the right hand is 46 instead of 23; it is doubled, whilst that of the left hand is a little diminished—12 instead of 16.

This diminution of the left side shows, that when the attention is intent upon one limb, a kind of compensation is made at the expense of the others. The same effect is noted when it is suggested to a somnambulist that he is endowed with great strength in one limb: that of the opposite diminishes. Conversely, when a psychical paralysis of one limb is produced,

the strength of the other is increased; there is not so much a loss as an alteration of distribution. If this characteristic was general among hemiplegias by suggestion, it would supply important data for diagnosis; for we know that in hemiplegia through gross cerebral lesion, there is, on the contrary, diminution of the strength on the opposite side.

I imagined, from certain observations, that sexual excitement did produce a momentary increase of dynamometric strength. The investigation of this point led me to the discovery of some interesting points. Dr. Chambard has shown, in some somnambulists, the existence of "erogenic" zones, irritation of which produces feelings of congestion of the generative organs, and erotic ideas. These zones, which are found chiefly on the neck and on the neighbouring portions of the thorax and head, do not lose their properties during the waking states; they exist in persons who have never fallen, or been placed, in the somnambulistic condition, and are even, perhaps, present, up to a certain point, in everybody. I tried to find, by exercising on them a slight pressure, whether these excito-genital zones were at the same time excito-motor, and found the dynamometric readings to rise to 38 or 40 on the right side, and to 32 or 36 on the left, according to the zone, cervical or sternal, excited. I likewise explored the hysterogenic zones on the same subject, and obtained similar results. I further discovered purely dynamogenic zones where the most energetic pressure produces nothing more than an increase in the dynamometric pression. Two such zones, placed laterally behind the bregma, or superior fontanelle, on each side of the median line, exercise a crossed action upon the hands, the dynamometer on the right side ascending to 42, on the left to 35 kilos.

These facts, which I merely mention here, seem to indicate a transition between the dynamogenic and the convulsing actions (hysterogenic and epileptogenic zones); the latter effect being only an exaggeration of the former. We see how dynamogenic excitations, such as intellectual exercise, may determine, when exaggerated, distinctly neuropathic states, susceptible of hereditary transmission. This is exactly what occurs in the case of the guinea-pigs, which, when made

epileptic through peripheral excitations, transmit this neurosis to their descendants. I shall, on a future occasion, return to the pathogenic influence of "mental overpressure" (surmenage intellectuel).

The very definite results, which are obtainable in hysteria, may sometimes be produced with the same intensity on healthy subjects, in whom fatigue has determined a state of irritable weakness, and thereby a hyper-excitability analogous to that of hysteria. Under the influence of fatigue, due to protracted intellectual labour, dynamometric force diminishes and tends to become equal on both sides. Let us suppose in the normal state 55 on the right and 45 on the left, we should find, under the influence of fatigue, 40 on both sides. If now we carry out passive movements of flexion of the hand, the dynamometer may show 60 on the right and 50 on the left; the strength of contraction has been brought up to the same degree as if the excitation has been made on the normal state; but its relative effect has been much more considerable. Hysterical persons are in a permanent state of physical fatigue, but various excitations may temporarily awaken their energy, as it may do also in neurasthenia.

I have often found that, under the influence of fatigue localised in the right hand, for instance, the left showed, on the contrary, an increase of one-fifth. This fact may serve as a link between paralysis by exhaustion and certain paralyses by suggestion, in which we have found that the dynamometric strength is increased on the opposite side. In confirmation of this view, we may state, that as passive movements do counteract the diminution of contraction due to general fatigue, so certain paralyses by suggestion may be cured by the same movements. This remark may perhaps be of use in the treatment of hysterical paralysis, where psychical alterations play such an important part.

We have already said that the act of *speaking* could produce an increase of dynamometric strength on the right side. Excitation in the opposite direction may be illustrated in a case of motor aphasia induced by suggestion. If in such a case we practised passive movements of all the segments of

the right arm, we should find that after a moment the power of speech returns, but disappears again as soon as the movements of the arm cease; the same result is obtained if the subject performs active movements with the right arm. This observation, which may perhaps also find an application in the case of certain hysterical aphasias, shows how the exciting influence of such movements is exerted on the movements of the organs of speech. It may also explain the persistency of the mimical movements of the limbs, which, though often without significance of their own, may nevertheless act as an excitant to the act of speech. Finally, it shows that the fact of the functional predominance of the right arm (of which the motor centre is on the left side), and the localisation of the function of language on the left side is not a simple coincidence, but that there is a cause for this relation. It is because the child has chiefly used his right arm, whether it be through instinct or education, that he speaks with his left brain.

I have observed that, generally speaking, psychical excitation is accompanied with an increase of motor energy, appreciable on the dynamometer when the experimental conditions are favourable. I have noticed, also, that certain peripheral excitations of the muscular sense have an analogous effect, which remains localised or becomes diffused according as the excitation itself has been more or less limited and pronounced. The facts relating to the special zones have shown the results of certain excitations of the general sensibility; and, finally, in the sexual sphere, we have observed effects of the same description. I have noted, by the way, that the hallucinations induced in hypnotised individuals have the same property of increasing the dynamometric force, whatever be the sense involved. When the hallucination is strictly unilateral, dynamogeny exists on the same side only—a fact, by the way, which gives a new proof of the reality of these induced hallucinations.

The existence of this dynamogenic property of hallucinations has led me to seek whether some analogous fact was not connected with the simple excitation of the several organs of sense. I discovered that a strong stimulus of sight,

hearing, smell, taste, or touch, determine in the healthy subject a notable increase of the deflection of the dynamometric needle; the reaction varied with the intensity of the excitation. I draw the conclusion, that *the impressions made upon the various senses have a common measure*, supplied by the dynamometer; all sensations are accompanied with an augmentation of potential energy, which appears to constitute the essence of a sensation. These facts, moreover, are in perfect harmony with the mode of embryonic development of the organs of sense, which have a common origin, but show their differentiation to be less complete than would at first sight appear to be the case.

Neuropathic, especially hysterical, persons, who normally present a certain degree of anæsthesia involving the muscular sense and a corresponding amount of weakness, display these phenomena on a magnified scale. On such a subject one may see the dynamometric power doubled under the influence of a vivid sensorial excitation; and memory, which is but a recall of the sensation, has, when intense, a similar effect. These facts show that *psycho-physiological functions are reducible to mechanical work*.

My experiments show, that under certain favourable circumstances the dynamometer may become a measure of sensation: I shall return to this point.

I have previously seen that, if a certain degree of cerebral excitation develops muscular energy, intellectual fatigue diminishes it; excitations of sensory organs have a similar result. If I tell a hypnotisable person to look at a moderately luminous object, a motor excitation is at once produced, which after a few instants decreases when the subject begins to complain of fatigue; if the excitation be continued, sleep supervenes. A continuous sound or mechanical vibration, &c. produces exactly the same effects, and in the same order of succession. When, instead of moderate and prolonged, the excitation is sharp and short, sleep may supervene at once. These facts are in accordance with those which Brown-Séquard has grouped under the appropriate names of *dynamogeny* and *inhibition*. They show that peripheral stimuli may produce, according to their intensity and duration, exciting or

depressing effects which may culminate into convulsions and paralysis.

When I consider separately the effects of stimulating each of the various sensory organs, I come to conclusions which are not without interest and points of concordance with one another. With reference to hearing, for instance, we find that sounds have a dynamogenic influence which varies with their loudness and their pitch; in other words, that *the intensity of auditory impressions, measured by their dynamic equivalent, is in relation to the amplitude and number of vibrations.* When I speak of these impressions I mean the uniform, monotonous sensations due to a single note. The compound auditory impressions constituting harmony, and to which memory and association of ideas may give a peculiar meaning, have a variable action according to circumstances. Hence we find different results according to whether we deal with lively or sad music; the latter is depressant, the former excito-motor. These effects, which in healthy subjects are readily made manifest on the dynamometer, support the conclusion which we shall deduce from further facts, that sensations are agreeable or painful according as they augment or diminish the potential energy. At any rate, it shows that it may be of importance to exercise care in selecting the pieces which children are made to play.

There is some reason in the idea long entertained, that music has an influence in the treatment of mental disease, but we see that its use must be based upon certain principles; it acts not as rhythm only, as some writers have asserted, but as sound in itself. We are at present engaged in a detailed study of the question of auditory impressions.

With reference to vision, the results are no less interesting. Observations on the hallucinations of hypnotised individuals have already shown, that colours are susceptible of being classified, according to their dynamogenic effects, into a certain order, which appears to be—red, orange, green, yellow, blue. Experiments made on real sensations have given similar results. The effects of the more active colours are very definite in many people, but more especially in nervous subjects. Thus, on the subject already mentioned, whose normal dynamometric power is equal to 23 kilos, we find that

when coloured glass or gelatine plates are used, red rays bring the pressure up to 42, orange to 35, yellow to 30, green to 28, blue to 24.

It will be observed that in these experiments on real sensations, yellow does not occupy the same position as it does in hallucinations. This deviation is highly instructive, for in some recent experiments made with M. Londe, in which we operated with the spectral colours by decomposing white light through a prism of sulphide of carbon, we found that the dynamic effects of coloured rays diminish from red, to orange, green, blue, violet; those of yellow being similar to those of blue, and much less marked than in our previous researches. The error in the first instance came from the fact that the so-called yellow glasses were really of an orange tint. It is interesting to note that, in the case of the hallucinations of hypnotised subjects, the colour suggested to the latter was of a perfectly pure tint.

It thus appears that, with this exception, the dynamogenic power of colours follows the same order as their spectral position; hence *the intensity of visual sensations varies with the vibrations.* The *vibration* therefore appears to be the hint of excitation as well for the sense of hearing as for that of sight. Does the same law hold in the case of the other senses?

With reference to the predominating influence of the red, it is interesting to remark, that it is the colour which seems to have most effect upon animals, and to be the first distinguished by children; the first also to have been recognised by man. Violet, which exerts a depressant action, has been used, as well as blue, with a certain success in calming maniacal excitement. Finally, we may add that special experimental dispositions have enabled us to ascertain, that for each colour the dynamogenic action varies with the intensity of light.

We have studied taste by the same process, and found that its fundamental sensations may be classified according to a dynamic scale, analogous to that of sounds and colours. Thus, sugar has a very low dynamogenic action; salt, a more marked action; bitter substances are the most active. Thus, on the hysterical subject of our previous experiments, the dynamometer

after sugar gives 29 kilos; after salt, 35; after quinine, 39. On normal persons, though less marked, the action of salt and bitter may be quite manifest. Acids are still more powerful, but their action is complex. General sensation and smell are affected at the same time, and their action is added to that of the sensation of taste. Acetic acid, for instance, is much more active than bitters.

The effects of sugar, &c., in solutions of definite strength show that they augment with the concentration, though not susceptible of being reduced to a mathematical formula. The dynamic condition of the subject under observation varies under the influence of the ingesta, &c. But if we cannot formulate a psycho-mechanical law, the general data are sufficient for approximations.

The dynamic influence of the sensations of taste, especially when associated with those of smell, may serve to clear up a point of physiology still controverted. There is a food, beef-tea, of which the nutritive value is contested, chemical analysis showing that it contains but a slight amount of, if any, alimentary material. In its defence, the view is taken that it must have some value, because the patient under its influence often regains some strength, and becomes capable of a certain momentary effort. It is certain that the action of this aliment on taste and smell may determine an excitation of strength, especially in an exhausted subject, for we have shown that under conditions of exhaustion, dynamogenic agents have a more marked influence. Beef-tea, as a sensorial stimulant, has a dynamic effect. The smoke of tobacco produces the same effect on certain individuals. This influence no doubt extends to the digestive organs, and may account for the eupeptic action. Certain bitters, considered as aperients, have a contrary action, on account, perhaps, of the over-excitation which they exert, either by themselves or by the substances which are associated with them.

Our studies of the olfactory sensations are less advanced. Still, we have been able to establish a kind of dynamogenic scale of smells, in which musk appears to occupy the highest position.

It may be said in a general way, therefore, that *all sensations*

determine the development of potential energy which passes to the kinetic state, and manifests itself by a motor action, capable of demonstration even by such rough procedures as dynamometric measurement.

The excitations of internal organs may determine similar dynamogenic actions. Thus, squeezing even lightly the os uteri, which in the normal condition is insensible, may determine an augmentation of dynamometric pressure. This observation shows that the stimulus need not be perceived in order to determine a mechanical action. This is an interesting point with reference to convulsions arising from non-painful visceral lesions; and as an illustration of this point, we may allude to a series of observations on the effects of the excitation produced by coloured rays on an achromatopsic eye when the dynamic effects were found to be parallel to those observed on the healthy eye.

Hence we may conclude, that *every peripheral excitation determines an augmentation of potential energy.* The consequence of any excitation whatever, whether of a physical or chemical nature, is a transformation of force, a modification of a form of movement. We have seen more particularly that for sensations of sight and hearing, there is a relation between the amount of stimulus and the amount of reaction, the strength of movement produced giving the measure, up to a certain point, of the initial vibration. The human organism, though so complex, thus reacts as would any other body to external action. Nothing but transformations have taken place, of which, it is true, many escape our means of analysis. This transformation of movement, as observed in the simplest organisms which react by an appreciable change of form, constitutes the essential function of nerve elements. Whether we deal with a simple reflex or a complex psychical operation, everything becomes reducible to a dynamic transformation which may be made evident by the exploration of the motor residua of cerebral action.

The human body behaves, in a word, like any other mass of matter which transmits a communicated movement, transforming it, however, according to its own molecular constitution. This constitution of living organisms however, or in

other words, the form of their peculiar vibrations, varies continually with the processes of assimilation and disassimilation. Each individual and each part of the individual reacts according to its specific energy, and the individual variations explain how every subject may transform differently a communicated movement, and how he may react differently to the same stimulus, according to circumstances. Some react chiefly to olfactory excitations, others to auditory, &c. We need not therefore have recourse to the theory of the perigenesis of plastidules and of plastidular vibrations, to account for these differences; direct observation is enough for their explanation.

The form of the vibratory movements of the body is modified every time it is placed in contact with another vibrating body. These alterations in the form of its vibrations account for the changes in the dynamic state observed under the influence of light, sound, &c. The vibrations of the diapason determine in certain subjects considerable functional modifications; magnets act in the same way, and metals according to their atomic constitution.

It is only by these modifications of the vibratory form of the body elements, and especially of the nervous system, that we can explain the phenomena of dynamogeny, of inhibition, of transfer, of psychical polarisation, which occur without any appreciable material modification.

The influence on the dynamic state of the vibratory form of the forces which come into contact with the external integument is experimentally shown by some of the facts previously described. We think ourselves entitled to conclude, that *psycho-physiological functions are reducible to mechanical work.* Mechanical work is easily recognised in the simple reflexes of inferior organism, but its study is more difficult when we deal with the complicated reflexes constituting the psychical operations; the process, however, is always the same. If we have insisted at such length upon these considerations, it was to establish once more that psychology of cerebral physiology must be studied by the general methods of biology. Experience is to form the basis of all natural sciences, and an effect is not to be denied because we do not understand its mechanism. We have experimentally shown that every stimulus, even when

not perceived, determines a dynamic effect. This result is of physiological, as well as pathological and therapeutical importance. Thus with reference to external irritations of revulsive actions, of which the influence is denied or exaggerated according to the rationalistic or empirical bias, our experiments may furnish a possible explanation. They show that the dynamic effects of peripheral stimuli are exerted, not only on voluntary muscles, but also on those of organic life; the augmentation they produce in the circulatory activity, for instance, is very clear, and long ago Haller observed that the sound of the drum increased the flow of blood from an open vein. Such an influence on the circulatory and nutritive activity makes plain how a blister, for instance, may determine nutritive phenomena, absorption of liquids, &c., with predominance on the same side of the body, but is capable also of acting at a distance. These circulatory effects of peripheral stimuli may also assist us in the interpretation of certain psychical phenomena.

I shall have occasion to return to the subject of motor manifestations in muscles of organic life under the influence of external excitations; but I may mention here that Majendie, Cl. Bernard, François-Franck, Couty and Charpentier, and others, have spoken, though with some divergences of opinion, of the cardio-vascular effects of sensory excitations. On the other hand, Cl. Bernard, Schiff, Vulpian, &c., have shown that the pupil contracts under the influence of exciting sensations; and certain emotions, such as anger (Jorissenne), have the same effect. The pupil dilates under the influence of pain, and depressant emotions such as terror; the same phenomenon is noticed in fatigue. Finally, in their experiments on the bladder, Mosso and Pellacani have found that excitation of any sensory nerve, as well as psychical activity, produce reflex movements of that organ. I may add that voluntary contractions of the anus, as recorded by a graphical process which need not be described here, are more energetic and durable under the influence of certain sensorial or psychical excitations. Hence we may conclude, that *every impression augments the energy of the whole organism.*

My more recent researches with the dynamograph have

fully confirmed all these results, and show in addition that the muscular contractions effected under the influence of excitations of the several senses differ, not only in intensity, but also in respect of their dynamographic curve.

As Spencer remarks, the phenomena of pleasure and pain are perhaps the most obscure and complex in psychology. It may, therefore, prove interesting to bring forward certain facts calculated to throw light upon their genesis.

I have already mentioned, with reference to auditory excitation, that painful sensation is accompanied with a depression, whilst agreeable sensations coincide with an increase of energy. I may add that, under the influence of pleasant or unpleasant emotions arising from any other cause, the same dynamometric variations are observed. When a subject is submitted to the process elsewhere described as *psychical polarisation*,[1] and which consists in a kind of inversion of the psychological condition under the influence of an external stimulus, the dynamic state is altered along with the emotive state. Conversely, it is manifest that colours or smells which will produce the most intense dynamogenic effects are as a rule pleasant. I have reached the conclusion, that agreeable or disagreeable sensations depend upon an increase or diminution of potential energy. Certain facts, however, relating to painful feelings seem to make an exception. The investigation of certain olfactory sensations may re-establish a concordance amongst these apparently conflicting data.

Dr. G., who is very sensitive to the action of smells, kindly consented to be experimented upon. After having found that the dynamometric pressure of the right hand varies from 50 to 55, we rapidly placed under his nose a bottle containing perfectly pure musk. Dr. G. declares the smell to be extremely disagreeable, his dynamometric force now amounts to 45, and therefore is diminished. The same experiment was repeated later on, but with the bottle held at a distance, so as to attenuate the impression. He now declares the smell to be pleasant, and his physiognomy clearly expresses satisfaction. His pressure now is 65; in other words, is augmented by 10 or 15 kilos.

[1] Binet and Féré.—'Revue Philosophique,' April, 1885.

In a hysterical patient who is anæsthetic, and shows a considerable loss of smell, the close contact of the musk determines a very agreeable sensation, and at the same time considerable dynamogenic effects (46 instead of 43). In another experiment on the same subject, the bottle was left in contact with the nostrils for three minutes. The sensation, after being pleasant at first, began to cause inconvenience, and the dynamometer now showing 19; in other words, a marked diminution. On keeping up the action of the musk, sensation becomes weaker, disappears, dynamometric action becomes lower, and finally the subject falls into a lethargic sleep. The olfactory sensations act exactly as those of hearing and sight; they all are exciting at the beginning, then produce exhaustion, and sleep in predisposed individuals.

This succession of phenomena shows that artificial sleep does not originally differ from normal sleep; fatigue is its primordial cause. This fatigue may be due to a sudden discharge of reflex movements determined by sudden stimulus, or is brought about slowly in consequence of a prolonged and monotonous impression. A similar sequence under the influence of one stimulus (strong sensation, disappearance of sensation, fatigue) is physiological, and may be observed in the case of many persons. It shows that an excitation, even when no longer perceived, still determines dynamic effects and fatigue. Unpleasant stimulus may cease to be felt without ceasing to exert mechanical effects, the absence of which is recognised when the stimulation ceases.

These various experiments coincide to show that pleasant sensations are accompanied with an augmentation, and unpleasant sensation with a diminution of energy. The sense of pressure resolves itself, therefore, in a feeling of power; that of pain in a feeling of powerlessness. Hence, we have here a material demonstration of the theoretical views more or less clearly expressed by Kant, Bain, and Darwin, upon pleasure and pain.

Now every stimulus which augments potential energy ends in a discharge; now gradual, when the stimulus is moderate, now sudden, when it is strong and determines reflex movements. The impression of ammonia on smell determines such movements; it produces a sudden discharge with rapid

depression of potential energy; hence a disagreeable sensation. The immediate and momentary increase of the dynamometric pressure is only the direct effect of the reflex discharge. Each discharge is accompanied with a diminution of potential, so that, beyond a certain limit, sensation ceases to grow proportionally to the excitation.

We have already seen that auditory impressions are followed by analogous phenomena of increase and diminution. Other sensory impressions do the same; those of sight show not only that the fatigue of an organ depends on a diminution of the potential energy of the subject, but also that this diminution coincides with a modification of the molecular vibrations. When one fixes the eyes for a long time upon a red square on a white background, green appears on its edges; this is the phenomenon of simultaneous contrast; on weak subjects, and in the state of fatigue, the phenomenon occurs more quickly; and it may be produced at once in certain persons by the application of a magnet, which acts by modifying by its own vibrations the molecular vibrations of the body.

Our chief object, however, was to show that pleasure and pain are correlated with the potential energy of the subject. The senses of sight, smell, hearing, taste, are not the only ones which demonstrate this fact; excitations of the genital sense are no less demonstrative in their effects. It is easy to account on these principles for the exaltation of energy, which grows to a paroxysm, and is followed after a while by a persistent depression. We need not insist upon the psychical states which correspond to this dynamic exaltation and depression.

These are remarks on the bodily phenomena which accompany pleasure or pain; the latter, being but a mode of fatigue, may serve as a basis to a physiological theory of æsthetics. And as pleasure and pain are at the root of what are known as sentiments, affections, elective affinities, these psychical states will also find their physiological explanation in the same considerations.

In a future contribution we shall bring new facts, furnishing a physical demonstration of the view that the living being does nothing but to restitute, under another form, communicated movements.

NERVE TROUBLES AS FORESHADOWED IN THE CHILD.

BY CH. FÉRÉ, M.D.,

Assistant Physician at the Salpêtrière, Paris.

We have elsewhere[1] adduced arguments tending to show that heredity is the primordial cause of nervous affections, whether they be characterised by somatic or by psychical disturbances. We have adduced a certain number of observations enabling us to generalise the views of Morel, of Moreau (de Tours), of Prosper Lucas, of Trousseau, of Griesinger, of Charcot, concerning the ætiology of these diseases.

But it must be admitted that in many cases it is impossible to follow up the hereditary evolution of the neuropathy, which may further be due to some disturbance in the conception, in gestation, or in the first childhood. No one doubts to-day that children conceived during a drunken debauch are peculiarly predisposed to idiocy, imbecility, epilepsy, &c. The passions, the emotions, may play the same part: a fact of which we have related an interesting example. Certain disturbances of body or mind during the course of gestation may have identical results, as shown by the statistics of the children born during the siege of Landrecies; and Legrand du Saulle has made recently interesting observations with reference to the siege of Paris. During early childhood defective hygienic conditions may sometimes influence the development of the nervous system, and take a share in the causation of certain more or less indelible pathological states. Thus, a prolonged lying on the right side may determine certain deviations of the form of the skull by lateral propulsion (Gueniot), which are the more readily produced if the young subject is at the same

[1] "La Famille Névropathique—Eclampsie et Epilepsie;" 'Archives de Neurologie,' 1884.

time affected with athrepsia (Parrot); and functional troubles of variable severity may result from this cause.

When no trace of degenerescence is discovered in the heredity of a subject, it does not follow that the nervous affection from which he suffers is accidental, arising from some purely fortuitous cause, such as a traumatism, or an infectious disease, &c. The patient may not have any hereditary taint, but be the victim of a disturbance of evolution which may not break out until the development of the nervous system has reached its completion.

The predisposition may thus result from an hereditary degenerescence, or from an evolutional defect giving rise to weak points which account for the systematisation of certain lesions, the localisation of the latter being determined by the defective evolution of the affected parts.

Hence, before we can admit the accidental origin of a nervous affection, it is necessary to eliminate not only the presence of any direct or indirect hereditary condition, whether similar or transformatory, but also that of any disturbance of evolution capable of bringing about a defective development of the nervous system.

To sum up: Before we speak of the accidental origin of a neuropathic affection we must make sure that the ancestors, and the subject himself, have never presented any nervous trouble. In order to determine the existence of the alterations which form the substratum of a morbid nervous predisposition, two orders of facts must be taken into consideration: some relate to organic changes, the others to functional troubles to which no certain anatomical basis can be ascribed.

Morel first showed that the insane were, more frequently than others, subject to bodily malformations. This remark has been confirmed by many observers, and we may now generalise the remark, and say that this tendency to degenerations is not peculiar to them, but is common to all subjects with a neuropathic disposition.

The anomalies of development may affect the whole organism, and thus men whose muscles, hairs, generative organs are little developed and present general analogies to a woman,—presenting in other words the feminine type

("*Féminisme*")—are very liable to various nervous accidents. A certain number of males suffering from hystero-epilepsy, for instance, present this aspect.

Conversely, women who by their external forms, their muscular development, the scanty volume of their mammary glands, their exaggerated hair-growth, especially in the submaxillary region, have virile characteristics ("*Masculisme*"), are predisposed to neurotic affections. Such women frequently suffer from the newly described forms of alienation which are peculiar to those in whom we recognise hereditary tendencies to degeneration.

A certain number of subjects of both sexes present a retardation of development (called "*Infantilisme*" by some authors), in consequence of which all the organs and tissues are more readily attacked by degenerations and infections. Lorain used to lay much stress on the frequency of tuberculosis among such subjects. It is to be noted that such subjects usually reach early the stage of decrepitude, and often show the characteristic features of *precocious senility*. The laws of evolution govern tissues and organs as much as individuals and species. We have shown[1] that the senile atrophy of bony tissue, for instance, shows itself first in the regions of most recent growth, and of most laborious development, and that these regions have the greatest tendency to become the seat of various pathological lesions. It is a well-known fact, that organs which have been late or disturbed in their evolution are more exposed to inflammations and organic degenerations; the pathology of the testicle, in particular, furnishes numerous examples of this kind (Le Double, Aubert). The nervous system makes no exception to this rule. A good many of the individuals affected with infantile spastic paraplegia are born before the term.

The anomalies of formation which stand in closest relationship to affections of the nervous system are those relating to the cerebro-spinal centres and their envelopes. We need not insist upon such malformations of the nerve-centres, which

[1] "Atrophie sénile symétrique des pariétaux;" 'Bull. Soc. anatomique,' 1876, p. 485; 1881, p. 414 et p. 72. "Contribution à l'étude de la pathogénie et de l'anatomie pathologique du céphalæmatome;" 'Revue mensuelle de Méd. et Chir.,' 1880.

act as direct anatomical causes; but we must allude to an arrested development of the rachis, spina bifida, more or less incomplete; to analogous defects of the skull and malformations of the head (asymmetry, microcephalism, &c.), and of the face (asymmetry, hemiatrophy, hare-lip, &c.); of the ear (congenital deafness, malformations of the concha, &c.); of the eye; arrested development of limbs; of the abdominal walls; herniæ; malformations of the genito-urinary organs, &c. All such developmental anomalies constitute the "stigmata" of the degenerative tendency, as they have been called.

A certain number of subjects, well formed at birth, are afflicted later on with deformities, such as strabismus, club-foot, &c., which have mostly succeeded to convulsions or spinal paralysis, &c., and of which the aspect often betrays the origin.

Anatomical lesions, however, are not the only characteristics observed in the subjects of nervous affections. On investigating their antecedents, one frequently finds traces of somatic or psychical troubles which constitute another group of "stigmata," viz. the *functional* premonitory troubles ("infantile preludes to neuropathies").

Among the functional somatic stigmata some are remarkable for the generalisation of their phenomena, whilst others are limited and remain unnoticed, or are looked upon with a certain degree of indifference. The importance ascribed to them varies also with the circumstances in which they have manifested themselves. Infantile convulsions, or eclampsia, are readily neglected in their prognostic significance, when occurring during dentition, after a blow, or mental shock, &c. The tetanus neonatorum and tetany often pass for accidental occurrences which will leave no trace. The same is the case for chorea, which we are accustomed to see treated as a complication of rheumatism, though it may also arise from traumatism or the puerperal state, conditions which, like rheumatism, do nothing but bring out the neuropathic predisposition. Localised spasms, even when accompanied by loss of consciousness, as for instance, the salaam convulsion or eclampsia nutans, are still more neglected; and more so again the "tics," such as facial spasm, torticollis, spasmodic sneezing, nocturnal spasmodic cough, trismus (especially

nocturnal), asthma, laryngismus, troubles of articulation, &c. With reference to neuralgias, more especially sick headache, scarcely any stress is laid on them, though they are rare in children, and always constitute a sign of neuropathic predisposition. In addition to these phenomena, we must allude to nocturnal or diurnal incontinence of urine. The nocturnal kind has already been well studied by Trousseau, who has pointed out its significance. Diurnal incontinence has not yet attracted sufficient attention; it occurs in the waking state, and may surprise the child in the middle of his games. Micturition is irresistible, and may be either complete or incomplete; the urine is expelled by jerks, either single or repeated. This diurnal incontinence is often, but not always, associated with habits of masturbation.

Certain individuals have peculiar dysæsthesiæ, which may involve every sense; some cannot bear to be in the dark without being seized with an invincible terror. Hobbes is said to have been seized with a sort of delirium as soon as he was left without a light at night. Others cannot bear certain smells, even the most pleasant; the compositor Grétry, for instance, could not endure the smells of roses.

The psychical "stigmata" are neither less various nor less frequent. Neuropathic individuals have often presented from their childhood peculiar characteristics. Some are torpid, lazy and indolent, or work only by fits and starts. They dislike movement under any circumstances, keep away from noisy games and every bodily exercise. They are prone to depression, and seek to be alone; they often experience sensations of "malaise," of pain, of moral dysæsthesia. They have the "ennui" of themselves, they fear the future without cause: a spot on a copy-book, bad marks for their lessons, plunge them into a dumb anguish which may last for days. They are sombre, dreamy, taciturn, sulky, suspicious. Sometimes this state of psychical malaise presents acute recrudescences, states of anguish (raptus melancholicus), with temptations to crime or suicide. The act is then only a reflex phenomenon connected with the psychical anæsthesia or paræsthesia. The states of painful psychical depression with irritability occur chiefly at the onset of puberty. Others, on the contrary,

are excited, always on the move, cannot remain in one place, or preserve a correct attitude, and are subject to abrupt, unruly movements. They are equally mobile from a psychical point of view, their desires are as changing as their attitude; this inconstancy shows itself in their affections and their tastes; what pleased them yesterday does not please them to-day: what they like to-day will be disliked to-morrow. Hence they often manifest a tendency for change and roaming. Such variations are the more readily appreciated, that these subjects always manifest an exaggeration of emotional movements and feelings.

We must remark here, that we do not consider the emotions as essentially pathological phenomena. What is required to establish the morbid character of an emotional display is the disproportion between its cause and its intensity. When a decapitated frog is subjected to an excitation of its inferior limbs, the leg performs a movement of defence; if the excitation is stronger, both legs enter into play; beyond this point the four extremities are convulsed. These movements bear a certain proportion to the intensity of the excitation. If the animal has been previously strychnised, the least touch produces such a generalised and exaggerated reaction. We find in man an analogous state of things with reference to psychical reactions; in a normal condition these reactions are proportionate to the excitation. If a man utters a cry of terror when lightning strikes near him, the reaction is normal; but when a hysterical subject utters the same cry on perceiving a caterpillar at a distance, it is a morbid manifestation, showing the subject to be strychnised, so to speak, by a morbid heredity, or a defective evolution.

As a rule, individuals predisposed to nervous disorders are strangely timorous; many up to the age of twelve or fifteen cannot remain alone, nor sleep without a light, &c. Sometimes, notwithstanding this timidity, they display audacity for mischief. Some have a tendency to cruelty towards other children, or towards animals; they are young criminals. Although, as a rule, extraordinarily active, they are incapable of attention or application when the object is a useful one. They often manifest a premature development of the

sexual instinct which frequently takes an unnatural direction; and excessive onanism still further exaggerates their depressed or emotional states, and brings into evidence the irritable weakness of the subject.

Finally, it is not rare for these individuals to show alternations of depression and excitation, which their friends attribute to variation of temper, and treat as unimportant, but which really constitute various phases of the same morbid state. These alternations are not unconnected with those attenuated forms of "folies circulaires," which M. Falret with much reason insists upon in his teaching. Such individuals are often seen to enter into a state of exasperation and convulsive passion, after a period of stupid resignation of variable duration. These fits of excitement break out sometimes with the suddenness of an epileptic attack; it is a real change at sight. We know of two cases of this kind in which the violent fits of anger terminate in a deep sleep with loud snoring, which reminds one of an epileptic manifestation. Whether excited or depressed, these children usually show marked perversions either of an intellectual or of an emotional description, such as eccentricities and depraved feelings. Some are of a generally weakened intellect; they learned to speak very late; they were unable to acquire more than a most elementary instruction, learning slowly and forgetting quickly. Others, though of deficient intellect, manifest remarkable special aptitudes for music, for numbers, and the like; "partial geniuses," as they have been called. These weak-minded individuals, besides a morbid obstinacy, manifest certain psychical plasticity, a peculiar suggestibility, which makes them liable to be incited to commit crimes beyond their power of conception. Thus we see them, according to the external circumstances, at times in a mood of kindness, at others extremely obnoxious. They are unable to bear a sorrow, and are easily frightened. Mental perversion and weakness are often associated, either form predominating;[1] the tendency to pyromania, or dipsomania, or kleptomania, which is comparatively frequent among young subjects with neuropathic heredity, is rarely associated with a normally developed intellect.

[1] Kahlbaum, 'Allgem. Zeitschr. für Psychiatrie' x. 4, 5.

Notwithstanding their condition of intellectual inferiority, they are often endowed with a true psychical euphoria; they are satisfied with themselves, and this satisfaction, which they sometimes get those about them to share, enables them to succeed in certain easy vocations. To these feelings of self-contentment is often associated a domineering turn of mind. Such individuals are hard and overbearing to their inferiors, whilst they are obsequious and humble to their superiors.

In addition to these psychical peculiarities, which constitute, so to speak, an habitual state, other accidental phenomena are observed, such as nocturnal or diurnal terrors, often occurring in sudden fits. The diurnal terrors are frequently systematized. Some are frightened at the sight of certain animals or insects; thus, Meyerbeer could not stand the sight of a cat. Or the terrors may occur at various intervals, and involve a great number of objects. Again, they may be constant, and extend to a single order of ideas, such as the fear of death, which in children, usually so light-hearted, even in the course of grave illnesses, constitutes a truly morbid symptom. We need not insist upon the significance of nocturnal terrors.

It is only after a thorough inquiry into the existence of such organic or functional disorders, and into the neuropathic troubles of childhood, that one can determine the value of the exciting causes of nervous diseases. Otherwise there is a danger of attributing to traumatisms or to infectious diseases an importance which they do not possess in reality.

The mode of action of traumatisms in the production of nervous complaints is not always the same. (*a.*) Sometimes it brings into play an already specialised predisposition; as when the subject of hereditary neuropathic tendencies, who has had several attacks of chorea, suffers a relapse after a more or less localised shock; or in certain complications of surgical injuries, such as in the case of J. Hutchinson, where a patient died of tetanus whose father had died of the same complication. (*b.*) The traumatism may also localise a general predisposition, as when it calls forth a hysterical contracture. (*c.*) It may hasten the evolution of the disease, as in tabes dorsalis, and look as if it were the efficient cause of it.

It is certain that, apart from any hereditary or congenital

predisposition, certain traumatisms, and more particularly those of the skull, of which the action is more direct upon the nervous centres, create a predisposition which may be designated as accidental,[1] but which probably always implies an anatomical basis. When the individual who has thus been "neuropathised" by an accidental lesion, has recovered, he remains predisposed to neuropathic disorders; he has acquired a special pathological habit; his nervous system will preserve a peculiar excitability which may henceforth be called into play by various excitations. What we have just said of traumatisms we may repeat of moral shock, of acute diseases, of intoxications. Morel had not failed to observe the frequency of neuropathic complications after acute diseases. He quotes, for instance, a family of eight children, who, after typhoid fever, had every one cerebral symptoms, but where a hereditary tendency was at the root of these accidents. General diseases, like traumatisms, create neuropathic predisposition only if they have accidentally determined lesions of the nervous system. Under these circumstances the subject "inherits of himself," as Lasègue remarked.

When we take into account the hereditary tendencies and the early manifestations which betray a disturbance of evolution, we shall see that it is not the predisposition which it is necessary to prove, but it is rather the absence of this predisposition which is to be doubted in the history of nervous diseases.

[1] Lasègue, "Les Cérébraux;" 'Etudes Médicales,' 1884.

ON STAINING "IN TOTO" THE CENTRAL NERVOUS SYSTEM WITH WEIGERT'S HÆMATOXYLIN.

BY CHARLES E. BEEVOR, M.D., M.R.C.P,

Assistant-Physician to the National Hospital for the Paralysed and Epileptic.

As I had the opportunity of working with Professor Weigert at Leipzig in 1882, and assisted him when he discovered his valuable method of staining the medullated fibres with acid-fuchsine, I have taken a great interest in his later discovery of staining with hæmatoxylin.

Ever since I saw his beautiful preparations shown at the International Congress at Copenhagen last summer, I have been trying to apply this last method to staining the central nervous system *in toto*, so that sections might be cut from the mass, and mounted at once without further treatment. The advantages to be gained by this method are of course very great, and a great amount of labour would be saved if a brain or spinal cord could be thus stained *in toto*.

My first successful preparations were made at the beginning of last October, and since that time I have continued working at this subject; as I have had a great many failures in trying to vary the method in different ways, I think that the means by which I obtained my first specimens will prove to be the most efficacious. This method consists in hardening the piece in methylated alcohol, then leaving it in potassic bichromate solution from one to four weeks, and putting it again into methylated alcohol for one to two days before using Weigert's hæmatoxylin.

The specimen on which I first worked was the whole brain of a marmoset—for which I have to thank Mr. Beddard, the prosector of the Zoological Gardens. By a mistake, this had been hardened in methylated alcohol for two or three weeks; it was then put into bichromate of potash solution, 3 per cent., for

another month; the brain was then cut frontally, *i.e.* vertically and laterally, into pieces about one-eighth inch thick, or less, washed in methylated alcohol for one or two days, and then put into Weigert's hæmatoxylin for four days, and on each day for three or four hours it was kept at the temperature of 40° to 50° C. The strength of the solution used was double that recommended by Professor Weigert, as I had found by a previous trial that it seemed to stain better than his original solution; I therefore used the following formula:

Hæmatoxylin	gr. xxx (2 grammes).
Absolute alcohol	min. 200 (14 gr.).
Water	oz. 4 (130 gr.).

The pieces of brain were then slightly washed in water and put into the solution of ferricyanide of potash (2½ parts), borax (2 parts), with water (100 parts); and this solution was changed till no more brown colour came from them; they were then washed in water.

The pieces were then passed through methylated alcohol, absolute alcohol, oil of cloves, oil of turpentine, and imbedded in paraffin, according to the method used at the Physiological Institute at Leipzig, and which I had learnt there under Dr. Gaule.

Sections were then cut, the paraffin removed by xylol, and mounted at once in Canada balsam.

A series of twenty-four of these sections mounted on two slides was shown at the Pathological Society during the past session; the first twelve showed all the naked-eye changes of structure, from the optic commissure to just in front of the pons, while the other twelve sections extended from the anterior part of the pons to about its middle. In these sections all the medullated fibres were very well stained.

I have since tried staining *in toto* specimens which have been hardened in bichromate of potash in the usual way, and afterwards put into methylated alcohol; but I have had so many failures with this method that I have been obliged to give it up. I have, however, stained the cord of a monkey *in toto* by hæmatoxylin, which had been hardened in bichromate of potash, 3 per cent., for two or three months; pieces were then put into methylated alcohol for a week, and then into

the strong solution of Weigert's hæmatoxylin for three days, and warmed for about three hours every day to 45° C. Sections cut from these pieces, after imbedding in paraffin, showed the whole white substance stained black, while the central grey matter had only its medullated fibres coloured.

I have further stained some of these pieces with picrocarmine *in toto*, after developing the Weigert process, and other pieces with eocene alcohol *in toto*, and have thereby brought out the cells of the grey matter and the neuroglia of the spinal cord in contrast to the darkly-coloured medullated fibres.

On the other hand, I have frequently failed to stain *in toto* with hæmatoxylin, after hardening with bichromate of potash in the usual way; and I have invariably failed when the pieces were put direct from bichromate solution into hæmatoxylin, without being first treated with methylated alcohol for a day or more. Where I have partially succeeded, the finest fibres of the grey matter were not properly stained, and often not at all.

With regard to the action of the bichromate solution; it does not seem necessary for the pieces to be hardened in this solution, as I have found on treating sections, cut from pieces hardened in alcohol, with bichromate solution for three to six days, and then immersing these sections for twenty-four hours in methylated alcohol, that they stain well with Weigert's method; and in this way I have re-stained sections cut from specimens which had been imperfectly stained *in toto*.

With regard to the new method with acetate of copper, published by Professor Weigert in the 'Fortschritte der Medicin,' April 15, 1885, I have as yet tried staining *in toto* with one specimen only, viz. a spinal cord from a case of locomotor ataxia. This had been hardened in bichromate of potash six weeks, and in methylated alcohol for about six months; pieces were put into the acetate of copper solution for five days, being warmed to 45° C. for three hours daily; then in methylated spirit for four days, changing the alcohol till no more green colour could be washed out, and in strong hæmatoxylin for four days, but without warming; the piece was then developed by ferricyanide of potash and sections cut from it. It was then seen that the whole of the white columns were

stained black, with the exception of the sclerosed portion; but the part of the columns nearest to the central grey matter were not so deeply stained, and in places were hardly stained at all; and the finest fibres of the grey matter were not stained well, and in parts not at all.

As these preparations have only just been made, I have not had time to try another specimen before writing this paper; but I think if the preparation had been warmed to 45° C., or had been stained a few days longer, that the whole piece would have been penetrated, and I hope eventually to attain this.

I should remark that in the paper mentioned above, Prof. Weigert states that he has tried applying his method to staining pieces *in toto*, but that he has obtained only imperfect results.

From his article I presume, that he has made use of staining *in toto* with his original method only, and does not refer to his latter discovery with acetate of copper. With regard to the former method, I think that my sections made from the marmoset's brain show staining of the finest fibres generally, and certainly bring out the fine fibres in the corpus striatum and optic thalamus, while the larger masses of the internal capsule, optic tracts and corpus callosum are completely stained.

I regret that I have not, as yet, had time to try and perfect staining *in toto* with acetate of copper and Weigert's hæmatoxylin; but in the one trial I made, nearly the whole of the white columns have been coloured black.

Clinical Cases.

TWO CASES OF SPINAL DISEASE ASSOCIATED WITH INSANITY: I. TABES DORSALIS; AND II. CHRONIC ATROPHIC SPINAL PARALYSIS.

BY WILLIAM DUDLEY, M.B. (LOND.),

Pathologist and Assistant Medical Officer, West Riding Asylum, Wakefield.

I.

A. B. æt. 54, single, surgeon, came under treatment in the West Riding Asylum, in March 1885.

Patient, who is an M.R.C.S. and L.S.A., entered the Army Medical Service, served in the Crimean War, and subsequently was a ship-surgeon for some months, visiting Australia. He again entered the army, and was in active duty on the West Coast of Africa for about three years.

Whilst there he had a sunstroke; he suffered also from "Gold Coast," or "bilious remittent fever," and contracted syphilis from a black woman. At this time he drank heavily.

He returned to England sixteen or seventeen years ago, but had not completely recovered from the effects of sunstroke, and was chiefly dependent on his sister for a livelihood. For a short time he carried on a low-class dispensing practice, until disabled by a paralytic seizure.

Patient has had three paralytic seizures. The first occurred seven years ago. "Whilst walking along the street he felt as if his left leg had been shot from under him. He gradually recovered the use of the limb. In another seizure the onset was sudden, and attended by loss of consciousness. He was dispensing medicine at the time. His sister coming into the Dispensary found him unconscious on the floor. Gradual recovery followed this attack."

He has become depressed and unmanageable, and keeps his bed for days together. Latterly he has become excited, deluded, and rambling in speech, disorderly, throwing anything which displeases him on the fire. He now suffers from incontinence of urine and fæces.

Family History.—His father and mother both died at an

advanced age. There is no history of any neurosis, phthisis or apoplexy. His father was intemperate.

Mental condition on Admission.—Patient is slightly excited, garrulous, affable; constantly calling for champagne and cigars. He answers questions readily and to the point; but his answers are given for the most part with little thought, and are unreliable. His memory is especially defective in regard to dates. Asked the date of to-day, he replies without hesitation, "25th Jan. 1885." He does not understand the nature of this place, although he has been told. He thinks it is a public-house, the "Bull and Mouth," and that he came here a week ago. When told again that it is a lunatic asylum, he endeavours to account for being here, by saying that he "went to Burnley a month ago on the 17th of March, with some friends; got drunk, and was sent here for safety." He declares that he had £550 in his pocket at the time, but that the money was taken from him.

He talks much in a very deluded, optimistic strain, *e.g.*, "I am a duke, and I will get the Queen to make you a duke to-morrow. She will do anything for me. She gives me £10,000 a year. I am going to Madeira on Monday in the Queen's yacht; will you come? I am going to buy an estate for £1000. I am going to be married to a duke's daughter. I will give you £10,000 when you marry my sister," &c. He takes up readily almost any grandiose suggestion that is made and adds to it. Thus when asked if he is still practising his profession, and if he has many patients, he replies that he is consulting physician to various European monarchs, enumerating half-a-dozen, and is in receipt of immense salaries from each. He offers £50 or £1000 indifferently to any one who will bring him a box of cigars. He is ready to scribble something perfectly illegible on any scrap of paper, and to give it as a cheque on his banker for any sum that any one desires. These "cheques" are filled up with the greatest expedition; the writing is merely a few wavy lines; he is in too great a hurry to write; it is such an unimportant matter to him. "Here, use my name, and they will give you the money."

He talks freely about the events of his earlier life, his memory for recent occurrences is more defective. With regard to the question of syphilis, he cannot state whether he had a true chancre or chancroid; at the same time, or at some other, he had a bubo, which has left a scar in the groin. He treated the sore and bubo with nitric acid and lotio nigra, and took calomel, and iodide of potassium internally. When asked the dose of calomel, he replied, "a drachm twice or three times a day, that is the ordinary dose." He says he has had lightning pains in his legs, but not for many years past.

Physical Condition.—Height, 5 ft. 4 in. Weight, 124 lbs. Cranium broad; of good frontal development. Hair and beard white; crown of head bald. Limbs equally nourished.

Patellar reflexes are entirely absent. Plantar, cremasteric, abdominal, and epigastric are present. Sensibility of skin of lower extremities appears somewhat blunted. Contact sensations are fairly well localised. There are no areas of anæsthesia or of hyperæsthesia. When blindfolded, he is unable to distinguish whether he is standing upon a boarded floor, a rug, or a pillow. The floor, he says, feels soft like a carpet.

His gait is very distinctly ataxic. He walks slowly, with his legs widely separated, and the feet spreading; the steps are short; the legs are thrown clumsily forward; the feet are raised too high, and are brought down rather heavily. He uses his arms largely to balance himself during progression, and is unwilling to walk without assistance, or some object to grasp to steady himself. He keeps his eyes fixed on the ground about a yard in front of him, and if asked to walk while looking up, his difficulty is increased, and he frequently glances downwards, involuntarily, as it were. When asked to stop and turn round, he does so slowly and with difficulty. He can stand with much swaying to and fro for a short time while his feet are close together, but not at all with feet together and eyes closed. He is quite unable to stand upon one foot. He can move his limbs with a considerable degree of force in all directions. He has little control over his bladder and rectum. His writing, when he takes care, is quite legible, and not very shaky. His grasp is tolerably good; that of the left hand is decidedly weaker than that of the right. The tongue is large and flabby, *its right half is much smaller than the left.* It is protruded somewhat jerkily. It is almost free from tremor, and can be moved freely to either side, or curled up. He swallows without any difficulty. Facial expression is somewhat vacant; the facial muscles are usually flaccid, but they can be made to contract voluntarily.

Pupils are circular; very small; right slightly the larger; there are no iritic adhesions. There is complete irido-plegia both in response to light, and also with accommodation; nor is there any dilatation upon cutaneous irritation.

All ocular movements are well performed. There is no diplopia or nystagmus. Sight is good, except that he is somewhat presbyopic. There appears to be no contraction of the field of vision, and colours are distinguished perfectly. The pupils dilate fully under the influence of atropine, and the disc is quite healthy.

Hearing is slightly and equally dull in both ears. Taste is perfect. The sense of smell is blunted, or certainly not acute.

Heart sounds feeble; no murmur. Superficial arteries are free from evident atheroma. There is very slight arcus senilis.

Lungs are slightly emphysematous.

Tongue fairly clean, flabby. Teeth very deficient in number and quality. Appetite defective; bowels rather costive. Liver dulness normal.

Urine normal.

April.—He is now much less excited, and his answers are more reliable. His delusions are less prominent and less variable. He thinks now that he has been appointed Clinical Assistant here, with a salary of £200 a year, rising to £700; he is ready to commence duty as soon as his keys are given him. He says he is going to enter the Army Medical Service again at a salary of £500 a year. He can obtain a post as a matter of course, and thinks himself quite fit for active service. He is going to see the Director-General, the Queen, &c., with regard to it.

Since admission, there has been but little change in the patient's physical condition. He can walk a little better, and has much more control over his bladder and rectum. His pupils are not quite so small, still immovable; the left is a little the larger. Plantar reflex is well marked in the left foot, almost absent in the right.

He has given no indication of any subjective sensory impressions, nor has there been any gastric or other crisis. He takes food well, and his general health and condition have improved.

II.

R. P., æt. 61, married, formerly a labourer in a mill, was admitted into the West Riding Asylum on the 7th of March, 1885. The history obtained with him was imperfect and unreliable, but it was stated that he had been more or less insane for about two years prior to his admission; that his bodily health had been gradually failing for several years, and that for at least a year before admission he had been entirely confined to the house and had been supported by his children. It was also said that he had for many years been very intemperate, and that his wife and daughter were suffering from venereal disease contracted from him.

Family History.—He has four children, all of whom are said to be healthy. No history of insanity in the family, but his mother is said to have been paralytic for several years before her death.

Mental State.—On admission he was somewhat depressed and emotional, but manifested no dementia whatever; was perfectly

rational, and gave a coherent and detailed history of his past life. He stated that about nine years ago, while working in a flour mill, he one day accidentally put his left leg through a trap-opening, the door of which had been carelessly left open, and that his body fell across and struck the edge of the trap. He did not feel much hurt at the time, and was able to go about his work as usual for about a week after the occurrence of the accident. At the end of that time, however, owing to gradual loss of power in the left leg, he was led to seek medical advice, and went into the Leeds Infirmary. After he had been there three days he became completely paralysed in both lower limbs; but after a course of galvanism, lasting for three months, he was able to walk with the aid of sticks. He stated that he never recovered half his former power in the affected limbs, but that about nine months after the accident he had recovered sufficiently to be able to go back to his work at the mill, at which he continued for about two years and three months, when he met with another accident. While doing something in connection with the working of the machinery, a weight of about nine stones fell upon his left hand, and he lay for several hours in that situation before he was discovered and released. On account of loss of power in the arm, he was taken next day to the Infirmary; but, in spite of treatment, the arm gradually wasted. He noticed that the right arm began to lose power about nine or twelve months ago, and it has gradually got worse.

Visual acuity has gradually diminished during the past three or four years, and his voice has altered in character during the past twelve months or so.

Physical Condition. — Height, 5 ft. 1 in.; weight, 94 lbs. Cranium rather small, dolichocephalic. There is an old scar about 1 inch in length running antero-posteriorly, situated at the superior angle of the occipital bone. Beneath this scar is a distinct depression as if from fracture. Hair is grey and thin, and the greater part of the vertex is bald. Irides greyish brown. Pupils, circular; diameter of right, 5¼ mm.; of left, 4½ mm.; do not react to diffused light, nor to a concentrated beam, nor consensually: contract very slightly with accommodation: do not react to cutaneous stimulation. No reflexes can be obtained in the lower extremities.

Tongue is protruded straight. It is free from tremor, and its movements are fairly well co-ordinated. The lips and facial muscles are steady.

All the limbs are much wasted, the atrophy being more marked in the upper than in the lower extremities, and the left arm and leg are distinctly smaller than the right.

MEASUREMENTS.

Right leg	..	5 in. below knee, 9¼ in.—Left, 8⅞ in.
Right thigh	..	6 in. above knee, 13⅜ in.—Left, 13¼ in.
Right forearm	..	5 in. below elbow, 5½ in.—Left, 5⅜ in.
Right arm	..	4 in. above elbow, 7¼ in.—Left, 6½ in.

There are no contractures of the limbs, except in the fingers to a slight degree. The muscles generally are very flabby and extremely wasted. Idio-muscular contraction is scarcely perceptible in any limb. The left leg has a notably incurved aspect, apparently due to wasting of the peronei muscles. This appearance is absent on the right side.

The upper extremities are extremely wasted. The forearms and hands are literally almost nothing but skin and bone. Many of the muscles appear to have disappeared entirely. The forearms are flattened upon the dorsal and palmar aspects. The thenar and hypothenar eminences have disappeared, and there are deep depressions between the metacarpal bones. Both wrists are dropped. The ungual phalanges are incurved so as to give the hand a clawed appearance, and this is more marked in the right than in the left. The upper arm and shoulder-muscles, especially of the left side, are also extremely wasted, as are likewise, but to a less degree, those of the back.

The lower extremities are more wasted proportionally below the knee than above; and the anterior and external muscles of the leg have suffered more than those of the calf.

The patient is unable to approximate the thumb and fingers. He completely fails to grasp with the left hand, and with great effort succeeds only in doing so very feebly with the right. He can neither pronate nor supinate the hands, nor can he flex or extendthe wrists. He can perform very limited and feeble movements at the elbow and shoulder, and somewhat better on the right than on the left side.

As regards the electric reactions of upper limbs, serial alterations present themselves in both rhomboidei and left pectoralis major: the anodic closing contraction had nearly overtaken the kathodic closing contraction in the right brachialis anticus and left triceps: whilst no faradic or galvanic reaction could be obtained with the supinators of the forearm, the extensors or flexors of the hand and wrist, the intrinsic muscles of the hand and the right pectoralis major.

The reactions may be tabulated thus :—

		FARADISM.	GALVANISM.
Deltoid	(right)	Minimum at 9.	KSZ > ASz.
	(left)	0	KSZ > ASz.
Rhomboid	(right)	0	ASZ > KSz.
	(left)	0	ASZ > KSz.

	Faradism.	Galvanism.
Biceps	(right) 0	KSZ > ASz + AOZ.
	(left) 0	KSZ > ASz + AOZ.
Brachialis A.	(right) 0	KSZ > ASz.
	(left) 0	KSZ > ASz.
Supinator longus	(right) fair with weakest current	KS—AS.
	(left) 0 with strongest	KS—AS.
Extensors of Hand (extrinsic)	(right) } 0 (left) }	KS—AS.
Flexors of do.	(right) 0	KSz > ASz.
	(left) 0	KS—AS—
Serratus Magnus	(both) 0	KS—AS—
Pectoralis Major	(right) 0	KS—AS—
	(left) 0	ASZ—KS—
Triceps	(right) minimum at 7	KSZ > ASz.
	(left) do. at 6	KSG > ASz.
Intrinsics of Hand	0	KS—AS—

He is quite unable to stand. When asked to do so he struggles wildly. If assisted into a standing position, he throws his arms and legs about in a disorderly fashion. His lower limbs double at the knees as soon as any weight is allowed upon them. When lying on the bed, with the legs extended, he can succeed in partially drawing them up, but can exert very little force if resisted. He can cross his legs, but cannot place the heel of one foot upon the toes of the other.

There appears to be a great deal of muscular starting, accompanied by distressing pain. He states that he has been subject for some time to excruciating pains in the limbs and body, and which he describes as like flashes of lightning.

Sensibility to pain is retained in the skin of the face and scalp, and to some extent in the neck, although in the latter situation it appears to be blunted.

At tip of right forefinger, he distinguishes two points, 1 centimetre apart.

At tip of left forefinger, at 2 centimetres apart.

In centre of right palm, at 3 centimetres.

In centre of left palm, at 4 centimetres.

On front of forearms he cannot distinguish two points 10 centimetres apart.

Sensibility to tactile impressions and to pain is considerably diminished in the lower extremities, and sensation is much delayed.

The integument in several regions is dry and scaly. On the front and outer aspects of the legs this condition is sufficiently marked to merit the term "ichthyosis."

Thoracic and abdominal viscera appear fairly healthy.

The patient has little control over his bladder and rectum.

At all times he has but little sensation during the passage of evacuations, and is frequently quite unconscious of the fact.

The senses of taste and of hearing are fairly acute, that of smell is abolished.

June 13th.—Since admission there has been no change in the patient's condition worthy of record.

CASE OF CEREBRAL ABSCESS.

BY ARTHUR E. W. FOX, M.B., F.R.C.P. (EDIN.),

Physician to the Royal United Hospital, Bath.

ADELAIDE B., aged 25 years, a servant, was admitted into the Royal United Hospital under my care on January 28th, 1885. For the following notes of her case I am indebted to our House Physician, Mr. Edward Cave.

January 29th.—The patient states that she enjoyed excellent health until a fortnight ago, when she cut the middle finger of her left hand; it bled freely, and she was much frightened. In the evening of the same day, she lost the use of three fingers on the same side, viz. the middle, ring, and little fingers. There was no abnormal sensation; simply loss of power in the extensors of these fingers, and this continued without change until four days ago, when the loss of power extended to the rest of the hand and forearm, and she has been unable to do anything with it since. She applied to the Hospital yesterday morning, but feeling very faint on her way home, was brought back, and was at once admitted as a patient into Victoria Ward. At the time of her admission it was noticed by Mr. Roberts, our late house-surgeon, that there was slight convulsive twitching of her left face and left leg.

In appearance she is a nervous-looking girl, very well nourished, with plenty of colour in her cheeks, in fact looks very well; is of a clear brunette type.

She has never been laid up by any illness; never had any form of paralysis; never aphonic; no present or past otorrhea; no history of any blow on head; never had any kind of fit.

There is slight choreic movement of the right upper extremity; no twitching of the face or legs; pupils equal, moderately dilated; contract readily to light; no paralysis of any of the facial or ocular muscles; none of the tongue, palate or larynx. The left arm and hand are paralysed, and the hand is slightly blue and congested as compared with its fellow, and a little colder to the touch. Although the movements of the left upper arm are impaired, the paralysis is most marked in the forearm and hand. She can move the limb, as a whole, freely in any direction, but she cannot flex, extend, supinate, or pronate the forearm or hand, nor can she move any of the fingers; there is nothing characteristic in the shape of the

hand, the fingers are very slightly flexed, and the thumb half opposed to the index finger. There is no loss of sensation. She can localise a touch accurately, but a moderately severe pin-prick produces no expression of pain. All the muscles contract readily to the faradic current. She winces a good deal when pressure is made over the upper dorsal spines. She has no headache, is not giddy, can walk quite well. There are no signs of disease in the chest or abdomen. Appetite always capricious, and has been indifferent lately. No nausea or vomiting. Tongue coated with yellowish moist fur; bowels well opened yesterday. Menstruation regular. Urine sp. gr. 1030, with no albumen or sugar. Temperature 98·4, R. 20, P. 90.

January 30th and 31st.—Much the same, no headache, vomiting or pyrexia. On *February 1st* felt rather sick, but did not vomit. *February 7th*, complained of a little frontal headache. Continued much the same until *February 11th*, when for the first time, she vomited her breakfast. No headache, no pyrexia; if anything, can move her left arm, as a whole, more freely, but the forearm and fingers are still absolutely paralysed.

On *February 12th and 13th* she vomited several times; vomit, yellow and bilious. On *February 14th* complained again of frontal headache, not localised, nor worse on one side than the other; no tenderness of scalp; nor pain complained of on moderately hard percussion over the vertex. No other alteration in her state.

On *February 15th* did not sleep all night; was very restless and tried to get out of bed. No actual delirium. Complained much of her head. Has not vomited since yesterday morning; bowels confined, abdomen much retracted. Pulse 54, regular, and of moderate volume. She has not spoken since 6 A.M. and this morning is heavy and torpid. The left arm is absolutely paralysed, but she moves her right limbs and, to a less extent, the left leg in an irregular restless way. Does not protrude her tongue when told. Facial and ocular muscles act normally. Knee-jerks normal; the plantar reflex slight, but obtainable. Both optic discs appear to be somewhat too red, and the veins rather large; no swelling of either disc, no hæmorrhages. There is no expression of pain on smart percussion of the head, but she moans and struggles when deep pressure is made over the cervical and dorsal spines. There is no retraction of head. She became perfectly comatose, and died about 6 P.M. the same evening.

Post-mortem, twenty-two hours after death.

Heart, lungs, liver, stomach, spleen and kidneys healthy. Ovaries and fallopian tubes normal. First molar tooth in upper jaw on left side is slightly carious, and the adjacent

bicuspid is reduced to a stump; both were extracted, no suppuration at the root of either. Nothing amiss in either Antrum of Highmore. No otitis; on removing the calvarium, dura mater appeared normal; was not adherent to the bones. There was no disease of the bones or evidence of any injury to the skull. On reflecting the dura mater, a prominent, convex, and fluctuating swelling was apparent on the surface of the right hemisphere, chiefly in front of the superior end of the fissure of Rolando, and extending down along the ascending frontal convolution. An incision was made into the swelling, and about ½ an ounce of pus evacuated. There was nothing amiss at the base. No meningitis. There was an average amount of subarachnoid fluid. The brain was placed in spirit

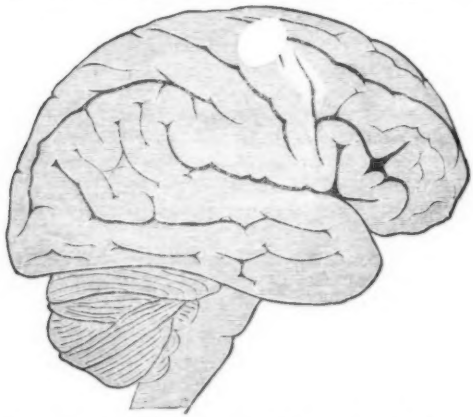


FIG. 1.—LATERAL VIEW OF HEMISPHERE. The white patch indicates position of abscess; the shaded patch, that of the softened brain matter.

and water to harden. Examined, after hardening in spirit, the abscess was found to be as big as a pigeon's egg, coming to the surface and so involving the grey matter, at the anterior margin of the ascending frontal convolution, 2 inches from the longitudinal fissure. (See figs. 2, 3, p. 254.) It extended obliquely, inwards and downwards, for 1½ inch towards the corpus callosum, while anteriorly it involved the posterior part of the superior frontal convolution. There was some reddish softening of the posterior portion of the second frontal. The abscess cavity was lined by a thick pyogenic membrane. The rest of the brain appeared perfectly normal.

Remarks.—This case is of interest in its insidious origin and comparatively latent course. The origin of the abscess is very obscure; there being no ascertainable history of injury to her

head, neither had she any bone disease, nor, as far as we could find, any pressing focus of suppuration. Lebert would probably regard the case as one of idiopathic cerebral abscess; but, in the face of the opinions expressed upon this subject by Gull, Sutton, Wilks and others, I confess that, though we took a great deal of trouble in our search, I consider that we must have overlooked the primary cause. Amongst other curious features in this case, are the small amount of headache and vomiting, and the complete absence of pyrexia from first to last. She never complained of headache, when questioned

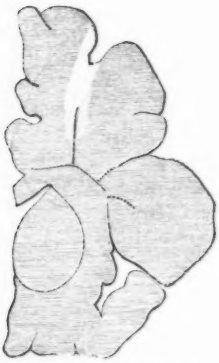


FIG. 2.—FRONTAL SECTION.

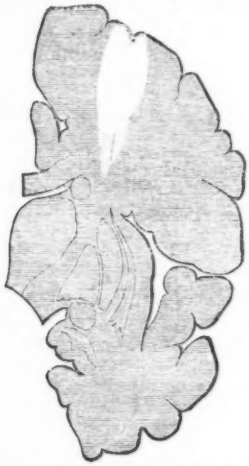


FIG 3.—PEDICULO-FRONTAL SECTION.

Showing position of abscess, and of softened region.

upon the subject, until February 7th, eight days before her death, and then it was never strictly localised, was of an intermittent character, and never severe until the last twenty-four hours of her life. The point of paramount importance in connection with the case appears to me to be the bearing it has upon localisation. The abscess involved, pretty accurately, the centre which Ferrier has laid down for supination of the hand, flexion of the forearm and extension of the arm and hand, the very parts paralysed in this girl's case. The fact that the muscles first affected were the extensors of the middle, ring, and little fingers of her left hand, corroborates Ferrier's statement,[1] that "a generally enfeebling cause will show itself first prominently in the extensors."

[1] 'BRAIN,' Part XV., page 311.

NERVE SUTURE; STRANGULATION AT POINT OF JUNCTION; OPERATION. RAPID RECOVERY OF SENSATION AND MOTION.

BY WALTER PYE, F.R.C.S.,

Surgeon to St. Mary's Hospital.

H. B., 25, a cellarman and bottle-washer, was admitted into St. Mary's Hospital, March 12th, 1885, with the symptoms of paralysis of the left ulnar nerve.

History.—He stated that at the end of 1883 he sustained a deep cut along the inner border of the left hand, through a bottle breaking as he was washing it. He went to the Royal Free Hospital, an anæsthetic was given, and some fragments of glass removed. The wound was dressed, and healed up directly. There remained, however, shooting-pains in the first and second fingers, with anæsthesia of the fourth and the ulnar side of the third fingers. He tried to resume his work; but a fortnight afterwards the wound broke out again, and he returned to the hospital.

Under an anæsthetic, Mr. Rose then opened up the wound by an incision made over the position of the ulnar nerve, at the wrist and bottom of the palm. The nerve-trunk was found to be divided, and was united end to end. The wound healed with a moderate amount of suppuration, but without further trouble. From that time until his admission into St. Mary's, there was no return of sensation in the fingers, while the scars, both of the original wound and of the surgical cut, became very acutely hyperæsthetic. There was also steadily increasing wasting of the palm of the hand, which got more and more clumsy and weak, so that he could in no way follow his trade. He finally came to Mr. Pye's out-patient room at St. Mary's, and was admitted into the wards.

Condition on Admission.—A healthy man, but poorly nourished.

The left forearm is marked in several places by the scars of cuts said to have been inflicted by fragments of bottles broken by him whilst washing them; the muscles of the forearm appear to be all equally developed. Along the course of the ulnar nerve, at the junction of the wrist and palm, there is a longitudinal scar crossed obliquely in the palm by another

(the oblique scar was that of the original wound; the long one, of the operation-wound). The former is much indurated, and in the centre is scabbed over only, but is firmly healed in the rest of its extent. The scab is exactly at the junction of the wrist and the palm, and here especially, but to a less degree over all the scar, there is an apparently acute hyperæsthesia, with reflex spasm of the flexors of the wrist produced upon the slightest touch.

The patient states that he cannot feel at all with the little finger and with the ulnar side of the ring-finger; but examination shows that, although the sensation is extremely impaired and altered, it is not quite abolished, so that he is conscious of a deep pin-prick, or a firm squeeze, although neither gives him pain; tactile sensation appears to be quite absent.

The hand is generally ill-nourished, probably from disuse, but the spaces between the metacarpal bones are especially wasted, and particularly the interval between the thumb and the first finger, this last being plainly due chiefly to atrophy of the adductor pollicis. The movements of the digits are clumsy, but can be performed, with the exception of complete adduction of the thumb and complete extension of the fingers.

Sensation in the palm, with the exception of the parts mentioned above as being hyperæsthetic, seems to be natural.

March 21*st*.—The patient was anæsthetised, and an incision was made following the line of the former one, being therefore in the line of the ulnar trunk. The nerve was exposed in the healthy tissues of the upper part of the wound, and traced downwards, being carefully dissected out from the dense cicatricial tissue in which it lay imbedded. It was in this way followed right through the scar, and down to its division into its superficial and deep branches in the hand.

These branches presented a normal appearance, as did the upper part of the trunk where it was first exposed, but between these two points it was obviously strangulated by the fibrous bands of the scar tissue; these ran through it and around it, the tightness of some of the circular constrictions being evidenced by the nerve swelling out on either side of the bands.

At the place which was obviously where the nerve had been originally divided and subsequently reunited, there was a well-marked bulbous enlargement, of about the size of, and presenting an appearance very similar to, the Gasserian ganglion.

As much of the fibrous infiltration and strangulating investment of the nerve-trunk as it was possible to dissect off without injuring the nerve-fibres was then carefully removed with the

scalpel, and the small nerve bundles separated one from another; the wound was closed, a short and very fine drainage-tube inserted, and the hand and forearm splinted lightly.

With regard to the wound, all that need be said is that its original dressing was never disturbed; and that it healed straightway without a drop of pus.

The following is the record of the process of return of sensation:—

March 25th.—Until to-day patient has noticed no difference in the fingers from their condition previous to the operation, but he now (four days after) thinks the third finger feels more natural; no change in the little finger.

March 26th.—The third finger is distinctly less numb, in his opinion, and the little finger is beginning to improve.

March 29th.—Hand removed from splint; the wound is healed. The improvement of sensation has continued, and he says that he feels as if he had more use in the hand. There is no perceptible alteration in its wasted appearance. There is no hyperæsthesia in the region of the operation-wounds, where it was very marked before.

April 9th.—The sensibility of the parts supplied by the ulnar nerve now seems to be quite normal, and as good as upon the other side of the body; he is confident as to increased usefulness of the hand; the wasting is, if anything, less.

April 11th.—Discharged, to recommence his work. He was afterwards seen frequently in the O. P. room at the hospital. The sensibility of the ulnar region is up to the present date (June 28th) permanently restored, and the weakness and atrophy of the affected muscles has steadily diminished, so that he now reckons that his left hand is about as good as his right one.

Remarks.—The whole interest of this case lies in the very rapid recovery of function shown by this nerve-trunk, after a suspension of its activity for a period of sixteen months after it had been divided and spliced together. This functional activity was, however, held in abeyance only, not abolished, and this was evidenced by the existence of some sensation, although it was only a very little, before the second operation. The atrophy of the muscles of the palm which are supplied by the ulnar was sufficient proof of the genuine nature of the case, and it is worthy of notice that the nerve-trunk below as well as above the seat of strangulation did not show, to the naked eye, any sign of impaired nutrition.

The recovery was, however, in any case singularly rapid and very complete, and the case would seem to encourage us to cut down upon and examine the condition of nerve-trunks, when

an operation for the reunion of their divided ends has not been followed by restoration of function, more frequently than is at present the practice.

It is well also to note the great importance of avoiding, in these operations, suppuration and the delayed union which it entails. This point has been already insisted on by writers on the subject of nerve suture.[1]

[1] Vide Mr. Herbert Page's paper. 'Brit. Med. Journ.' vol. ii., 1880, p. 347.

Reviews and Notices of Books.

Les Maladies de la Personnalité. Par Th. Ribot, Directeur de la 'Revue Philosophique.' 1 vol. 18mo., pp. 174. Paris: Félix Alcan.

The leading idea in this very excellent and important work is the expansion of the "sixth sense." In all metaphysical works the existence of sensations over and above those which arrive by the five senses is mentioned, but until this work of M. Ribot, a bare mention is all the notice that these so-called "organic" sensations have received; and the extremely important rôle that they play in mental life has escaped appreciation. It has long been recognised that the visceral or organic sensations were a factor in the totality of consciousness, but the precise part played by them, and the very great importance of their share in the constitution of the conscious *ego*, have been worked out by M. Ribot in a way that has never before been attempted; and that marks a real and considerable step in the progress of the science of Mind.

When Psychologists of the physiological school have investigated the material basis of Mind, they have understood by Mind definite states of consciousness—percepts, concepts, memories, emotions. They have investigated the conditions of *that which is known* apart from and without regard to the conditions of *that which knows* Discussions on the nature of the *ego* have been left to the introspective school, and have not been illuminated by the light which physiological investigation has thrown on the other departments of mental science. M. Ribot sets himself, in this volume, the task of applying in this most obscure region the same luminous principles which have enabled such great advances to be made in other directions, with the result that we are now able to say, that "the people that walked in darkness have seen a great light, and they that dwell in the land of thick darkness[1] upon them hath the light shined."

Although professedly treating of disorders of the personality, and marked off into chapters treating respectively of organic, affective, and intellectual disorders, yet the work is essentially physiological rather than pathological, and the facts of pathology are used mainly for the purpose of illustrating and enforcing the author's doctrine of the material basis of the conscious subject.

In order to appreciate the real concrete personality, and not an abstraction that is mistaken for it, we must not, says M. Ribot, shut ourselves up in our own consciousness with closed eyes and

[1] Revised Version.

obstinately question it; on the contrary, we must open our eyes and look about us. The child, the peasant, the artisan, millions of people who are going about their business, who have never heard of Fichte and Maine de Biran, who have never read an essay on the *ego* and the non-*ego*, have nevertheless a perfectly distinct idea of their own personality. It is necessary to account for this conviction of the multitude as well as for the uncertainty of the philosopher, and the explanation is to be found in the introspective view of the one and the practical experience of the other.

The objections so commonly made by a class of superficial thinkers against all introspective study are really valid when applied to the introspective study of the personality, and it is to this limited portion alone of the introspective method that these objections are applicable. By introspective observation we can observe states of consciousness, and these only, and we cannot hope to discover by analysis of these states a synthetic whole such as we believe the personality to be.[1] Hence, metaphysicians have considered states of consciousness mere accessories, and they have postulated the existence of some mysterious substratum which eludes observation, as the canvas on which the scenery of consciousness is painted, or rather as the sheet on which its dissolving views are displayed. It is this hypothetical substratum which, under the name of unity, or identity, or continuity, is considered the true *ego*. It is clear, however, that this principle of individuality is nothing but an abstraction—a verbal explanation which we have been content to accept for want of clear insight.

According to M. Ribot, the conscious *ego* is the subjective expression of the objective unity of the organism. Objectively and subjectively the characteristic feature of the personality is the continuity, the permanence, which we call identity. The conscious identity is nothing but the internal manifestation of the external identity which we witness both in ourselves and in others. When fully expanded, this expression has a very clear and definite meaning, and captivates more and more the judgment of the reader.

It is an axiom of physiological psychology that all consciousness is an accompaniment of nervous action. Without nervous action there can be no consciousness; but, on the other hand, there is an immense field of nervous action that has no conscious accompaniment. Nevertheless, there is no definite and no constant division between the portion of the nervous system whose activity is accompanied by consciousness, and the portion whose activity is not so accompanied. Ordinarily, that is to say, in normal waking life, the most vivid consciousness accompanies action of some part of the highest nervous centres, and there is a gradual shading off of consciousness—a gradation of tones and sub-tones corresponding with activity of centres similarly grading down towards the

[1] The true *ego* is that which feels, thinks and acts without itself coming into consciousness. It is by its very nature the subject, it is *subjectissimus*. To become objectified in consciousness it must undergo a transformation which must change its very nature.

lowest. It is to the highest centres that are mainly carried those impressions that we receive from the outer world by our sense organs. It is in these centres that are mainly registered the impressions of sight, of hearing, of taste, &c., and it is to these impressions that the attention of psychologists, and especially those of the introspective school, has been almost wholly devoted. But in addition to impressions of this class, there is an enormous aggregate of impressions arising from within the organism which are continuously flowing towards the superior nervous system, and which must be taken into account before our concept of the substratum of consciousness can be complete. Nerve currents starting from the whole of the interior of the organism—from the mucous and serous surfaces; from the viscera, the muscles, the bones, the articulations; from the arteries and even from the nervi nervorum—are continually flowing upward to the brain; their waves are continually breaking on the shore of the great central nervous territory—breaking not always on the same line, but nearer to or farther from the highest centres, according as the tide of nutrition ebbs and flows in the organism at large. Just as our consciousness of the world around us—object-consciousness—depends on the impressions brought by the nerves of sense to the highest centres, so our consciousness of our own personality—subject-consciousness—depends on the impressions brought by the visceral nerves to centres chiefly below the highest. Remark how the subject-consciousness corresponds in all respects with this aggregate of impressions pouring in from all parts of the organism. Note first, that while all states of consciousness by which we know the environment are intermittent, the consciousness of being—the personality—persists throughout. The continuous, ever-present, subject-consciousness corresponds with the continuous, ever-present, wash of the waves of the cœnæsthesis. The intense nerve-currents set up by the impact of disturbances from without upon the organism, correspond with the intense states of consciousness that arise from them. Lights, sounds, tastes, smells, touches, are of various degrees of intensity, but all are of high intensity compared with the deep ground-swell of feeling that arises from the interior of the organism itself, and maintains a consciousness of small intensity, it is true, but ever present, of the continuity of our existence. Conversely, the state of consciousness aroused by even the greatest of the external disturbances is of small volume compared with the consciousness, faint though it be, but voluminous and all pervading, of continuous identity of the subject.

Even in sleep, when the impressions from the outer world gain no entrance, we continue in dreams to be conscious of ourselves; and why this subject-consciousness remains will be evident, when we remember that the impressions on which it depends are distributed largely in the lower centres, and that the diminution and arrest of activity which constitutes sleep begins in the highest centres and spreads gradually downward.

If this be the constitution of the physical substratum of the

subject-consciousness, then it is evident that the *ego* is not a homogeneous unit, as the metaphysical doctrine implies, but an extremely complex whole. It is not an "essence," but a co-ordination. Its physical substratum being in nerve-centres which represent every portion of the organism, it is evident that an alteration in any portion of the organism must be represented by a corresponding alteration in the nerve-centres—must involve a corresponding alteration in the *ego*. Hence as a body grows old the individual feels aged; not by deliberately counting up the years that he has lived, but by the mirrored representation in consciousness of the changes that the body has undergone. Hence as the body changes by the addition or subtraction of functions, as at puberty and the menopause, so the individual changes by the addition or subtraction of faculties. Hence, a high state of vigour in the nutrition of the body is mirrored in buoyancy of spirits; and imperfect tissue-changes, in mental depression. It must not be forgotten that the brain itself is a viscus, and as such contributes its share to the molecular turmoil of the cœnæsthesis. On the existence of a high degree of tension in the nervous elements depends the sense of energy, of capacity to act strenuously, which is so important an element to both the existence and the feeling of well-being; and on the capacity to store large amounts of force in the nerve elements depends the quality on which more than all others depends success in life—the quality that is known as "staying-power."

The total consciousness that we have at any moment is a compound of the subject-consciousness, and the object-consciousness. Hence, if the subject-consciousness changes, our whole consciousness will not be the same even although the object-consciousness remains unchanged. Hence it is that we see things, as we say, in a different light. They are the same, and yet they are changed—to us. "After ten years of absence, an object, a monument, is seen the same, but it is not *felt* the same." There is a difference, sensible but intangible. There is a curious feeling of identity commingled with novelty, due to the commingling of an identical object-consciousness with a new subject-consciousness. "'Tis we, 'tis ours, are changed, not they."

It is unnecessary to follow M. Ribot through the various disorders of the personality of which he treats. They are considered more for the light that they throw on the physiology of the subject than for their intrinsic importance, great as this undoubtedly is. It is sufficient to say that no book treating of this subject approaches the value of M. Ribot's admirable treatise, and no student of psychology can afford to neglect to make himself master of it.

Gehirn und Auge. By Dr. LUDWIG MAUTHNER. 1 vol. 8vo., pp. 255, with 10 woodcuts. Wiesbaden; J. F. Bergmann, 1881.

THIS work, which forms part of the first volume of Professor Mauthner's 'Lectures on Ophthalmology,' has already proved its position as an authoritative account of the subject it treats. Professor Mauthner's method is that of historical development. He nowhere begins his account of a subject with a statement of the present opinion regarding it, but traces the formation of opinion through its various phases, showing how successive fallacies have been eliminated, and where we are still in uncertainty. This method has its advantages and disadvantages: but considering the difficulties of the subject, and the fact that to a certain extent each case of central nervous disease with ocular symptoms has to be thought out in a way very similar to this historical development, we consider the method has much to commend it.

Professor Mauthner, after a short account of the development of the optic nerve and retina, commences with much-needed definitions of the varieties of hemiopia, hemianopsia, or, as he terms it, hemianopia. It is much to be regretted that there is so much confusion on this head. Are hemiopia and hemianopsia synonymous terms? Do they refer to the retina, or to the field of vision? Does lateral hemianopsia mean defect of the temporal halves of both fields of vision, or of homonymous halves? Dr. Ross in his work on the Nervous System makes hemiopia refer to the retina, *i.e.* to the blind half of the retina; hemianopsia to the field of vision, *i.e.* to the defective half—a distinction certain not to be carried out from the very structure of these words, and still more certain to cause confusion. It seems that it would be better if the term hemiopia were dropped entirely. Hemianopsia, from the analogy of hemiplegia, hemianæsthesia, might be taken as referring to the retina, but general consensus makes it refer to the field of vision. Hemianopia homonyma dextra or sinistra means, then, according to Professor Mauthner, the loss respectively of the right or of the left halves of both fields of vision; hemianopia heteronyma lateralis or temporalis, of the temporal halves of both fields, and hemianopia heteronyma medialis or nasalis, of the nasal halves. The meaning of hemianopia homonyma superior or inferior, and of hemianopia heteronyma supero-inferior will be readily intelligible. Hemianopia should not be used as meaning both sides, unless the term homonymous or heteronymous is added. Professor Mauthner gives an account of each of the varieties, with an analysis of numerous clinical records. Under this head he discusses exhaustively the arrangement of the fibres in the optic nerves, chiasma, and optic tracts, with full reference not only to the pathological lesions of these parts, but also to development and physiological experiment. His own work on Amaurosis in 1872 marked an era in this inquiry. Dr. Mauthner's explanation of the ophthalmo-

scopic appearances in an old hemianopia, and of the various complaints of hemianopic patients, are particularly clear and interesting.

Taking up next the more difficult subject of the course of the optic nerve-fibres in the brain, Dr. Mauthner discusses first Charcot's scheme of a supplementary decussation in the anterior corpora quadrigemina. This, principally on the ground of Munk's experiments on the visual centre, he rejects, showing that Charcot's cases of hysterical hemianæsthesia, on which largely his plan was based, in reality do not support the scheme, but, so far as they go, strengthen the belief that each optic tract ends entirely in its own hemisphere, viz. in the occipital lobe. This latter view is supported and discussed along with an interesting section on "Seelenblindheit." We could have wished that the nervous symptoms accompanying hemianopia had been more fully discussed. This part of the work is meagre and unsatisfactory, and we doubt not that, with increased material, Dr. Mauthner will in his next issue make substantial additions to this important portion. A full and clear account is given of the various appearances in neuritis and neuro-retinitis associated with central disease, and of the various theories as to their causation. The work finishes with a somewhat fragmentary account of the other ocular symptoms in diseases of the nervous system.

JAMES ANDERSON, M.D.

Ophthalmiatrische Beiträge zur Diagnostik der Gehirnkrankheiten. By Dr. HERMANN WILBRAND. 1 vol. 8vo., pp. 100, with coloured plate. Wiesbaden: J. F. Bergmann, 1884.

THE anatomy and functions of the retinæ, optic nerves, commissure and tracts are now, we may say, matters of certainty. We know the effect of lesions of each of these parts, and these effects are in agreement with known anatomical arrangement. One point alone, perhaps, is inferred independently of known structure—namely, the bilateral central connection of each macula. This assumption seems the most natural explanation of the escape of macular visions in both eyes when the lesion of the visual tract lies posterior to the optic commissure. At the same time, direct intracerebral commissural connection of optic centres cannot be regarded as excluded. As the optic tracts, however, disappear from view through the corpora geniculata, our certainty ceases both anatomically and physiologically, although we are not absolutely without light. The clue is almost wholly physiological and pathological, and seeing that decisive cases must necessarily be few, and will also seldom be observed with the requisite knowledge and accuracy, the progress of certainty in this region will necessarily be slow. Dr. Wilbrand, in his work on Hemianopsia and its relation to the localisation of Cerebral Diseases, has

already gathered up many of the results derivable from pathological lesion, and the present work may be regarded as a continuation and extension of the former.

Dividing the visual sense into light-perception, form-perception, and colour-perception, Dr. Wilbrand devotes Chapter I. of his work to the statement of various propositions as to the position and relation of the centres for these faculties. First, from the fact that focal lesions in the optic radiations of Gratiolet beyond the primary optic centres at the posterior termination of the optic tracts, abolish all three visual perceptions, he concludes that these primary optic centres do not bring optical impressions within the sphere of consciousness. Second, from the fact that in hemianopsia one of these faculties may be destroyed, the other two remaining intact, he concludes that these faculties reside in distinct centres, as no such condition ever results from disease of the chiasma or optic tract. Lastly, from the fact that colour-vision may be destroyed alone, or may be destroyed along with partial or complete destruction of form-perception, and that the limits of the destruction of light-perception are always either the same or less extensive than those of the two other faculties, from this he concludes that the fibres concerned in colour and form-perception must pass through the light centre. The visual centres he considers we have good ground for locating at the apex of the occipital lobe; but he does not decide whether the three centres for colour, form, and light are disposed in different layers of the cortex (the first being superficial), or side by side in the same layer. Dr. Wilbrand elaborates his theory in considerable detail, and illustrates it by a coloured plate. Each proposition he supports by the reference to the cases collated in Chapter II. Some of the details necessarily possess an *à priori* rather than an inductive character, and Dr. Wilbrand does not pretend that the proofs are in all points absolutely convincing. Even as a painstaking attempt to establish on a clinical basis a theory of the central relation of colour, form, and light-perception, to render definite what has been vague, the work is worthy of careful perusal. Its main value lies, however, it seems to us, in the second and third chapters, which may be read quite independently of the theory stated in Chapter I. The first of these two chapters is devoted to the classified record of cases of disturbance or destruction of colour, form, and light-perception, with an interesting account of amnesic colour-blindness. In Chapter III., Dr. Wilbrand discusses the differential diagnosis of lateral, *i.e.* homonymous hemianopsia as due to lesion of an optic tract, of the pulvinar, of the optic radiations, of the cortex, or of the two last combined. We subjoin a *résumé* of his conclusions. (1.) In lesion of one optic tract we have lateral, *i.e.* homonymous, hemianopsia of the opposite side, always absolute, *i.e.* involving all three visual perceptions, and nearly always complete, *i.e.* involving all the field of vision to the right or left of a vertical line through the fixation-point. Marchand's case of softening affecting the lateral part of one tract, shows that it is possible for the hemianopsia to

be incomplete. Subsequent amaurosis invading the other halves of the two fields of vision, indicates invasion of the chiasma, and is in favour of affection of the optic tract rather than central lesion. Pupillary reflex on illumination of the retinal area involved is absent, or there may be a tardy reflex due to dispersion of light. With the bilateral hemianopsia following invasion of the chiasma, the pupil is dilated and motionless to light. Photopsiæ may be present. (2.) In lesions of the pulvinar, the hemianopsia will be absolute and stationary, the pupil will react to illuminations of the implicated retinal area, and there will usually be temporary hemiplegia and hemianæsthesia. (3.) In lesions of the optic radiations, the hemianopsia will be absolute, but complete or incomplete; the pupillary reflex will be retained; the patient will often have photopsiæ, and symptoms of hæmorrhage, &c., will usually be present. (4.) In lesions of the cortex in the occipital region, the hemianopsia will be absolute or not absolute, complete or incomplete. A lesion of the tip of one occipital lobe may produce absolute and complete lateral, *i.e.* homonymous, hemianopsia. Destruction of colour-vision, with retention of form and light-perception, probably means damage just behind the external parieto-occipital sulcus, and a gradual extinction of form and light-perception would imply extension of the lesion towards the tip of the occipital lobe. In cortical hemianopsia, the pupil reacts promptly to illumination of the implicated retinal area; and when the lesion is double, and there is therefore bilateral hemianopsia, both pupils still react. The patient in such cases never has photopsiæ, and it is impossible to produce them.

JAMES ANDERSON, M.D.

De l'Aphasie et de ses différentes Formes. Par le DR. BERNARD. 1 vol. Paris: Delahaye, 1885. 8vo., pp. 270.

THE author bases his account upon the Lectures delivered in 1883 by Professor Charcot. He adopts and describes fully the four types of Aphasia known as Aphemia, Agraphia, verbal blindness, and verbal deafness, and devotes much attention to the history of the progress of science on this subject. His vindication of the claims of Broca is very vigorous, and reveals an important fact, viz. that the rights of Dax to the position now generally ascribed to him are by no means so firmly established as his Montpellier supporters have led us to believe. In fact, it is very doubtful whether the now famous memoir on the localisation of Language in the left hemisphere was ever read publicly, and it would appear that it first received publicity on the 25th of May, 1865. The whole discussion is worth reading (pp. 23 *ff.*). The history of the varieties of Aphasia called "sensorial," is not by any means complete. This is, no doubt, owing to the fact that the author, who appears to be master of the French language only, has been

unable to avail himself of the writings of foreign authors. We regret the fact, for the history of verbal deafness could have offered him ample scope for vindicating unrecognised claims. We allude chiefly to the strange neglect in which Dr. Bastian's remarkable paper, published sixteen years ago,[1] has been allowed to lapse.

Wernicke (1874) and Kussmaul (1877) are everywhere mentioned as having been the first to describe sensorial aphasia. And yet we find the English author expressing himself on the subject in no uncertain or ambiguous terms. He divides cases of Aphasia into four categories: Aphasia proper, Aphemia, Agraphia, Amnesia.

"In Amnesia there is an inability to recall words, *i.e.* they properly cannot be revived in the auditory perceptive centres . . . in this condition we obviously have to do principally with defects of the cortical grey matter rather than with defects of afferent or efferent fibres, connecting this with lower centres" (p. 478). And he relates (p. 215) a case in which the patient suffered from verbal deafness.

It is to be remarked that, for Dr. Bastian, the process of thinking in words involves the activity of the auditory centre; in other words, that a train of such thought implies a series of revivified sounds of words. He has defended this view with much ability against Professor Bain and others, who lay great stress upon the so-called "motor images." We do not find that Dr. Bernard, in the discussion of the important subject of the relationship between speech and thought, has grasped the importance of the point involved. His assumption that destruction of Broca's convolution produces "motor amnesia" is gratuitous, even on the supposition of the motor nature of the process of thinking in words, or "inner speech"; for he has not proved that the motor cortical zone is the repository of experiences derived from *conscious* muscular sensations; nor does he even seem aware that, failing this, he is assuming the highly improbable factor of a clear consciousness of efferent nerve-actions. Our criticism implies, of course, that the word "memory," applied by the author to motor and sensory processes, has the same sense in both cases, and does not, in the first case, designate merely the result of *unconscious* nerve-action in the building up of co-ordinative mechanisms.

Another deficiency in the work before us is the insufficient attention paid to the distinction between cortical and commissural Aphasias. This topic has recently been fully worked out by Lichtheim[2] who, like most other writers, is unaware of Dr. Bastian's published views, and quotes Wernicke as entitled to priority on this point. And yet the former, in the paper already quoted, insists upon the existence of intercentral commissures and their significance in pathology.

[1] "On Loss of Speech in Cerebral Disease;" 'Brit. For. Med. Chir. Review,' vol. 43, 1869.

[2] 'Brain,' January 1885.

"It seems almost certain that impressions from the organs of sense to the perspective centres in the cerebral hemispheres travel along definite routes, although we may be more or less ignorant as to what those routes are, and also as to the extent and situations of the ground occupied in the cerebral hemispheres by the general perceptive centres . . . we may be sure that such centres exist somewhere, and are in connection with afferent fibres. . . . And because strong associations grow up between impressions [in different centres] we are entitled to infer that abundant communications exist between any single centre and all the others" (p. 477) . . and in the succeeding pages Dr. Bastian goes fully into the symptoms arising from interruptions in those communications. The latter topic is still more fully treated in the 29th chapter of his work on 'Brain as an Organ of Mind,' written, we are told (p. 619) in 1878, before the author had seen Kussmaul's recently published monograph.

To Dr. Bastian, therefore, belongs the undoubted credit of having been the first not only to speak of cortical sensorial centres, but also to draw the vital distinction between motor and sensorial, and between central and commissural Aphasia. Dr. Broadbent, in a very remarkable contribution on "the Mechanism of Speech and Thought,"[1] starting from this position, adopts the hypothesis of distinct perceptive centres, and shows reason to localise the auditory centre "in the marginal convolutions of the hemisphere," adducing instructive examples of what we now call, after the German authors, word-deafness. To Wernicke belongs the credit of having still further defined the localisation of the auditory word-centre, and proved its existence in the first temporal convolution.

Notwithstanding the criticisms we have passed over Dr. Bernard's book, we are certain that its perusal will repay all those interested in the question of Aphasia. It is full of interesting matter. Among other details we may mention a case, transcribed in the original Latin of 1673, in which an instance of word-blindness is accurately described. The patient could write in several languages, but could not read a word, even of what he had written himself:

"*Quod mirum est, si nomen ipsi aliquod vel dictio scribenda traderetur, promte illum et orthographice in quocumque ipsi antea noto idiomate scribere sciebat, scriptum autem propriâ licet manu legere, vel characteres distinguere et dignoscere non poterat.*"

A. DE WATTEVILLE.

[1] 'Medico-chirurg. Transactions,' vol. 55, 1872.

Topographical Anatomy of the Brain. By J. C. DALTON, M.D., Professor Emeritus of Physiology in the College of Physicians and Surgeons, New York. 4to, 3 vols. pp. 175; 48 plates. Philadelphia: Lea Brothers and Co., 1885.

THIS magnificent work not only reflects the highest honour upon its author, but does full credit to those whose artistic and typographical skill has been put to contribution in its publication. It consists of a series of splendid heliotypes taken from photographs of the brain and sections of the brain under different aspects. Every plate is accompanied with an outline-figure containing the references to the explicative text. All illustrations are natural size. The author gives a full account of the methods which he adopted to overcome the considerable difficulties encountered in preparing the brain so as to yield faithful photographs of its natural appearances. The fresh brain supported by the calvaria is immersed, with the base upward, in a fluid of a little less than its own specific gravity. The author recommends the mixture of sodium chloride solution (sp. gr. 1026) with a small quantity of glycerine, as the most serviceable for this purpose. The ventricular cavities are then injected with a warm solution of gelatine by means of a fine canula introduced into the infundibulum, which should be preserved entire for that purpose. The injection should be continued until the ventricles are moderately filled and the gelatine begins to exude between the crura cerebri and the hippocampal convolution; after which the brain is placed in a refrigerator and the gelatine allowed to solidify. This secures the normal condition of the internal parts.

The next operation consists in imbedding the brain in a mass of gelatine, of about its own consistency, in a metallic framework so constructed as to allow of successive sections in the horizontal or vertical plane. The arrangements for cutting the sections were not quite the same for the different series, but we have no space for the details. In cutting, the knife and the section were flooded with equal parts of glycerine and water. The sections were allowed to remain for twelve hours in a refrigerator immersed in the saline solution before being photographed.

The difficulties of photographing were most successfully overcome. The sections had to be imbedded in gelatine, or immersed in glycerine and chloride of sodium solution. In the latter case, the pictures were taken from the image of the preparation in a properly disposed mirror.

In the first volume (10 plates) the external convolutions are represented. It includes a good view of the insula and operculum, obtained by a longitudinal section parallel with the median plane; and one of the parts exposed by another longitudinal section 5 millimetres deeper than the base of the insula. The relative position of the internal parts comes out in a very clear and instructive manner in Vols. II. and III., which give respectively

fifteen representations of horizontal, and twenty-three of vertical transverse, sections. Each section is made 5 millimetres beyond the preceding, so that the study of the successive plates allows the reader to obtain a very clear idea of the relative position of parts in the highly complex mass of the brain. The simultaneous use of the horizontal and vertical sections will still further assist him. Prof. Dalton has spared no trouble to render the descriptions lucid, and to bring into relief the clinically important features of the parts. The reader must remember that these volumes deal with topographical anatomy only, and that the problems of the course of the fibres and all histological disquisitions are outside its scope. Though thus limited, the work will be found to hold a unique and important position. It is a question whether any anatomist ever investigated the organ on the same plan and in so systematic a manner as Prof. Dalton has with so much success. At any rate, no series of plates at all comparable to these has hitherto been published before. The heliotypes represent things exactly as they appear in nature; the white and grey matter, the winding maze of the convolutions preserve their life-like appearances in the plates; and whilst the faithful outline-figures enable the student to identify at a glance the various structures, he realises to the full their mutual relations of parts under aspects never presented in the ordinary processes of dissection and anatomical teaching.

A. DE WATTEVILLE.

Injuries of the Spine and Spinal Cord without apparent mechanical Lesion, and Nervous Shock in their Surgical and Medico-legal Aspects.—By HERBERT W. PAGE, M.A., M.C. Cantab., Surgeon to St. Mary's Hospital. London: Churchill. Second Edition, 1 vol. 8vo., pp. 397.

WE are glad to find that a second edition of this volume has already been called for. It deals with a very important subject, both from a medical and an ethical point of view; and even where the author's opinions may appear to go somewhat beyond the facts he adduces, their expression has largely contributed to elicit further investigation and discussion. Mr. Page's searching criticism of the ideas conveyed by the expression "Concussion of the Spine," have done much to pave the way to a more scientific view of the nervous disturbances which so frequently follow railway accidents. Under this name a number of incongruous elements were heaped up together; and nothing was easier for medical men giving evidence in a court of law than to fall into hopeless confusion and contradiction with themselves and with others, when submitted to a searching cross-examination. Spinal and meningeal hæmorrhages, compressions, inflammations on the one hand, mere functional disturbances on the other, besides possibilities of ulterior chronic

inflammatory or sclerotic processes developing without any apparent immediate lesion, not to speak of a respectable contingent of "neurasthenic" or hysteroid manifestations, were all included within the elastic boundaries of a single morbid type. What appears to be the truth is that in most cases, besides more or less apparent external bruises, the victim of a railway accident suffers from what has been more or less aptly called "traumatic neurasthenia," partly due to actual cerebral shock, partly to the emotional disturbance at the time of the accident, and to the ulterior anxiety attending the usually protracted legal proceedings. It would be an interesting point with reference to the alleged curative influence of good damages, to determine whether such patients recover more quickly in countries where the claims are smaller, and the worry and complications attending a law-suit are of less portentous magnitude than in England.

It is obvious that the amount of genuine nerve disturbance, as contrasted with what the patient puts on when examined, must always be a difficult point to define. Some differences of opinion must necessarily arise in many cases. But a more important point still, is to determine how far Mr. Page has established that organic changes in the cord never, or only quite exceptionally, follow a mere "jar" of the organ. That such an occurrence is much more rare than is assumed by Erichsen, seems evident—especially in the case of individuals who at no previous period of their lives have offered any evidence of an inherited or acquired neuropathic predisposition. But is it irrational to suppose that a shock may play the same part as over-use, and by exhausting nerve elements determine the outbreak of an impending organic process? We have read of cases, and seen at least one, in which, post-mortem, the cord presented alterations of which the exciting cause appeared to have been a mere shock without immediate lesion. At any rate, such occurrences as the recent death of a schoolboy from blows received on the back shows that apparently superficial injuries may lead to serious results; and we must not forget that, though ordinary "traumatic neurasthenia" has usually a tendency to recovery, there are well-authenticated instances where the patient has remained a martyr to his functional troubles for a long time, if not for life, after the accident with which his misery began.

The second edition of Mr. Page's book is chiefly a reprint from the first. In the third he will perhaps find it possible to modify the controversial tone of some of the chapters, and enforce his views by a more systematic arrangement of his facts and arguments. His main position is a strong one; and he may now safely remove the cause of truth from the agonosphere of personal opinions into the calmer regions of critical judgment.

A. DE WATTEVILLE.

Abstracts of British and Foreign Journals.

"How the Blind Dream."—By Mr. B. G. Johns. (*The National Review*, April 1885.)—In the dreams of most persons a mental vision is vividly produced during sleep, in which they perceive their friends moving about and conversing as in the ordinary real business of life. Now it is very obvious that such a dream cannot occur to a blind man; he cannot recall form and colour of which he knows nothing, and which an ordinary person has gained through impressions on his retina; his dream can extend no further than can be furnished by the faculties which he has retained. He may recall a person or a place, but the recollection can only be commensurate with what he has obtained by the senses of touch, hearing or smell. A blind boy dreamed of his brother who was dead. He knew him by his voice, and he also knew he was in the fields with him, for he felt himself treading upon the grass and smelling the fresh air. His idea of a field could not possibly reach much beyond this. Another man dreamed he was in his workshop; he knew this by sitting on a box and by the tools which were in it. A blind tramp said when he dreamed it was just the same as when he was awake, he dreamed of hearing and touching.

Mr. Johns mentions the case of a man who dreamed of a ghost. This suggests a question of very great interest. Do the blind believe in ghosts, and if so, in what manner do they come, and how are they recognised? A ghost is an apparition or ethereal being, generally resembling some person known in the flesh; it cannot, however, be felt, for it is transparent; a bullet may pass through it, and if sitting in a chair, it does not prevent another person occupying the seat at the same time. It is therefore generally admitted with Herbert Spencer that touch is the only reliable sense as a test of reality, is the one indeed into which the others may be reduced. When Macbeth could only see the dagger but could not feel it, he called it a dagger of the mind. How then can a blind man believe in a ghost known only by hearing and touch? It seems to us a contradiction, and yet Mr. Johns has a ghost story. A blind man dreamed he went to a house where he met a comrade who had been

sent to prison, and he thus described his dream. "I heard a voice at the door, and I said, 'Bless me, if that ain't John,' and I took him by the sleeve, it was his shirt-sleeve I felt, and I was half afeard of him, and surprised he was out weeks before his time. Then (in my dream) I dreamt that he tried to frighten me, and make believe he was a ghost by pushing me down sideways, &c., after that I waked and heard no more." This is a very curious account of the blind man's state of mind; he recognized his friend, but the latter behaved in so strange a way as to make the blind man believe he was a ghost. The pushing him down sideways, however, does not suggest a spiritual being to an ordinary mind. It would be a matter of great interest if Mr. Johns, or other persons coming in contact with the blind, would make further investigations into the subject of ghosts as conceived by the blind. The well-established ghost, clothed in white and quite impalpable, can scarcely have a place in the blind man's imagination.

SAMUEL WILKS, M.D.

Abstracts of Papers on Diseases of the Nervous System that have appeared in the Guy's Hospital Reports, 1874–1884.

1. Insular Sclerosis of the Brain and Spinal Cord. By W. MOXON, M.D. 1875.
2. On Meningeal Hæmorrhage. By J. F. GOODHART, M.D. 1876.
3. On Cerebritis, Hysteria, and Bulbar Paralysis. By S. WILKS, M.D., F.R.S. 1877.
4. On Unilateral Atrophy and Spasm. By FREDERICK TAYLOR, M.D. 1878.
5. Report on Cases of Tetanus treated in Guy's Hospital. By FREDERICK TAYLOR, M.D. 1878.
6. A Case of Disease of the Brain with Descending Degeneration of the Spinal Cord. By FREDERICK TAYLOR, M.D. 1879.
7. History of the Physiology of the Nervous System, taken more especially from the Writers on Phrenology. By S. WILKS, M.D., F.R.S. 1879.
8. Note on a Case of Tetanus.—By R. E. CARRINGTON, M.D., and G. A. WRIGHT, M.B. 1879.
9. Reflex Action in Diagnosis. By P. HORROCKS, M.D. 1881.
10. A Case of Symmetrical Softening of the Corpora Striata, followed by Bilateral Descending Degeneration with Secondary Anterior Poliomyelitis. By W. HALE WHITE, M.D. 1882.

11. On Hemianæsthesia. By S. Wilks, M.D., F.R.S. 1883.
12. A Case of Extensive Cerebral Softening with Descending Sclerosis in the Lateral Column. By G. N. Pitt, M.A., M.D. 1883–84.
13. Saturnine Lunacy. By J. F. Goodhart, M.D. 1883.
14. The Theory of a Heat-centre from a Clinical point of view. By W. Hale White, M.D. 1883–84.

1. This paper was the first English account of this disease. The author points out that the disease can be diagnosed with certainty: its diagnostic characters are:—I. A peculiar trembling of the head and limbs during movements, ceasing when the parts are supported, so that whilst in bed the patient gives no sign of his malady, but does when he attempts to move, thus differing from the movements in paralysis agitans which are more even, do not stop when the part is at rest, and are not accompanied by any extreme idiocy of manner. The movements of insular sclerosis are most like those of mercury poisoning, but differ in that they affect the head and neck, and have the character of embarrassed helplessness. II. Paralytic weakness, especially of the lower extremities. III. Contractions and rigidity chiefly of the lower extremities; they bear direct proportions to the paralysis. IV. Nystagmus; this symptom may be late, it is earliest in the cerebral form of the disease. V. There is little or no disturbance in power over the excretions. VI. As a rule, the electro-sensibility as well as the electro-motility are normal. VII. The words appear to cost too much pains, and are produced one syllable at a time, each syllable accentuated. VIII. There may be great enfeeblement of mind. Although, as might be expected, considering the diffuseness of the lesion, the symptoms vary; still, amongst this variety, there is a constant set as above enumerated. It is most common at the ages of 25–45; it is very chronic in its course, and death is usually accidental. The morbid anatomy is evidently that of chronic inflammation scattered in a broadcast style, especially in the white substance of the nervous centres producing patches of deep grey tint. The minute anatomy is shown very well in the spinal cord, where new sclerotic tissue is seen to advance inwards from a medullary ray, and all stages of the chronic inflammation may be seen. The paper concludes with a description of eight cases, in two of which there was an autopsy.

2. Meningeal hæmorrhage may be due either to variation in the blood pressure, or disease of the vessels. Out of 41 cases, 28 had either hypertrophied heart or granular kidney. Probably the

condition of periarteritis of the cerebral vessels described by MM. Bouchard and Charcot as causing miliary aneurisms, and so cerebral hæmorrhage, is the same thing as Drs. Gull and Sutton have described as hyaline fibroid degeneration of the arterial walls, and which is associated with chronic renal disease. The theory, therefore, which ascribes cerebral hæmorrhage to anomalies in the vascular tension is probably correct. Syphilitic disease of the arteries is one cause of meningeal hæmorrhage. Aneurism of the vessels at the base is a common cause; it generally exists in young people, and is a sequel to embolism. Mere excitement, or a sudden fit of passion, may, by inducing great pressure within the cerebral vessels, cause death. Three cases due to purpura are recorded. This may or may not be the result of blocking the vessels of leucocytes. The most constant symptom of the fatal cases is coma; of those that do not die, rather persistent stupidity remains. Meningeal hæmorrhage is difficult of diagnosis from alcoholism; the general appearance must be taken into account. Cases undoubtedly get well, but care must be exercised to avoid all excitement. The prognosis must depend upon the suddenness of the onset (one case in ten dies instantly), the completeness of the coma, the condition of the heart, the hardness of the pulse, and the state of the arteries. When the death is sudden, probably the medulla is implicated, either by pressure, or some disturbance of the circulation in it.

3. In this paper Dr. Wilks places on record some cases of cerebritis. In instances of cerebritis a large part of the cerebral hemisphere is involved in the inflammatory process, including the grey matter on the surface, the medullary matter within, and sometimes the central ganglia. As regards symptoms, there is no paralysis; the patient is simply devoid of mental power; there is generally no other symptom than this torpor, even if the meninges are involved. In unilateral meningo-cerebritis there may be some paralysis of the opposite side of the body. A case illustrative of this is given, but the patient did not know that she was paralysed. In this paper the doctrine that Dr. Wilks has often taught is emphasised, viz. that the formation of the animal body in two halves, and with two sets of nerves, necessitates the separation of the nerve-centres whenever an independent action of the limbs is required. The splitting of the spinal cord is a necessity of this independent action, and from this again of necessity follows a separate cerebral ganglion to rule over each. The mode in which

the two sides receiving different impressions can combine into one is by means of the commissure, and the explanation is no doubt of the same kind as that of single vision with two eyes.

The spinal cord may pass into the same condition that the brain does in sleep, and this is probably the explanation of some forms of hysteria with paralysis, and in hysteria with movement, there is over-action.

4. A case is recorded of a woman who, when a child 5 years old, was in the hospital for paralysis of the left arm and leg. She was admitted again when 27 years old. The left upper was much smaller than the right, the arm was close to the side, and there was flexion at the elbow, wrist and metacarpo-phalangeal joints; there were slow constant movements of the fingers. The left lower was also smaller than the right. She died of phthisis. There was found an old lesion in the grey matter of the corpus striatum, more or less atrophy of the right hemisphere, crus, pyramid, and olivary body, of the left hemisphere of the cerebellum and left side of the spinal cord. The right side of the base of the skull was smaller than the left. The history of the case was particularly clear; there could be no doubt but that the disease in the corpus striatum was primary; the atrophy of the other parts of the brain, as well as of the osseous and muscular structures, secondary. Some cases of congenital paralysis will bear a similar interpretation. The conclusion of Cotard, that partial atrophy of the brain is not a primary affection, but the result of traumatic, inflammatory, or other lesions, is justified. In the case here recorded there was no secondary degeneration, because the internal capsule was not involved. The case is interesting in confirming anatomy by the atrophy of the opposite half of the cerebellum. Eight additional cases are collected at the end of the paper. Out of the nine cases, seven commenced at or before the fifth year. Some of the cases were ushered in by convulsions, some by exanthemata; the paralysis is equally right and left, but always more in the upper than the lower. Sometimes the muscles are much wasted; sometimes in a state of painful tonic contraction, with slow involuntary movements; sometimes in a state of spastic contracture. The majority were subject from time to time to convulsive seizures, with or without loss of consciousness. There was very often some mental deficiency. The points of diagnosis from infantile paralysis are the hemiplegic distribution, the absence of marked atrophy in most cases, or the hypertrophied condition of the muscles that may be present in

some, the co-ordinated spastic contraction, the electrical reaction, the fits and the mental condition. The relation of this spastic hemiplegia, with slow movements, to the newly-described athetosis is discussed.

5. In this paper the cases during eleven years are recorded. Out of 51 cases available for statistics, 8 recovered; the traumatic cases were found to be more acute than the idiopathic; recoveries occurred more amongst cases of slight injury than amongst cases of severe; more recoveries took place amongst the cases in which the tetanic symptoms followed late upon the injury than amongst those in which they came on quickly; a more slow and chronic type of disease was more frequent amongst cases of mild injury than amongst cases of severe injury. In 12 out of 28 cases in which a post-mortem was made, there was lung mischief, in 13 nothing special was found. Of the 8 cases that recovered, 1 had Calabar bean; 1, Calabar bean and chloral; 1, Calabar bean, chloral, and morphia; 1, chloral; 1, chloral and iodide of potassium; 1, opium; 1, curara; 1, nitrite of amyl. In most of the Calabar-bean cases the drug was very rapidly pushed, either by subcutaneous injection or by the mouth; one patient took 125 grains of the extract in thirteen days, on one occasion he had seven successive doses of one grain each at intervals of fifteen minutes; 8 cases had Calabar bean alone; 2 had Calabar bean and chloral hydrate; 2 had Calabar bean, chloral hydrate, and morphia; 12 had chloral, and one of these had iodide of potassium added; only 1 case was treated simply with opium; 4 cases had curara; 3 cases had nitrite of amyl. The drugs used unsuccessfully were, quinine—bromide of potassium, bromide of ammonium, succus conii, Cannabis indica, nicotine, atropine, and aconite. Each case depends so much on its own merits, that, before any rigorous conclusions can be drawn, the article must be read in extenso.

6. A boy, aged 6, fell on his head six months before admission to the hospital; since then he has complained of pain, has seemed stupid, and has vomited; has lost power over his legs, and become blind. After admission, he got slowly worse; the face became paralysed; tonic contraction of the arms set in. At the end there was difficulty of swallowing; he gradually became emaciated and died. At the autopsy the following parts of brain had a gelatinous appearance; the posterior part of the corpus callosum and the posterior lobe on each side continuous with it; only the

posterior part of the corpus striatum was affected; the optic tracts ended in a mass of gelatinous material occupying the posterior part of the optic thalami and geniculate bodies. Sections of the pons, medulla, and cord showed disease occupying just those seats usually occupied by secondary degenerations, but rather darker and more defined than usual. The nature of the gelatinous material in the brain is discussed. Tumour, inflammation, and embolism appear to be excluded, and the degeneration shows no evidence of what preceded it. The secondary degeneration in the pons and cord is very interesting, because the posterior part of the internal capsule only was affected, and it therefore supports the views of Flechsig. Histologically, the condition in the cord was remarkable for the entire absence of granule cells, the absence of dense connective tissue, the great development of nuclei in the sheath of the vessels, and the substitution of a material, colloid in consistence and granular in structure, for the nervous and supporting elements of the tissue.

7. In this very interesting paper Dr. Wilks gives an account of some of the writings of the phrenologists, and of the transactions of the Phrenological Societies, and shows that they were not altogether worthy of the derision which their views excited. Dr. Wilks says, "I cannot but be struck with the great object which the writers presented to themselves, and the mode in which they proposed to prove the truth of their doctrine. Their object was the same as is now considered most rational. They discarded the notion that the brain was to be regarded as simply associated with the mind and there left, but they looked upon it as a compound and complex organ. They were the first who replaced the old method of the anatomists of slicing up the brain, by unfolding and dissecting it. They showed that it was made up of parts, each having its own function." Reference is made to a very able paper in the 'Phrenological Journal' for 1836, by Mr. Watson, entitled, "What is the use of the Double Brain?" and it is shown by quotations that the author had anticipated the views of Dr. Wilks on the duality of the brain, owing to which we have a double consciousness. Dr. Wilks takes this opportunity of giving clearly and fully his views on this subject. The phrenologists were remarkably accurate in the position in which they placed the seat of language; thus, Gall says, "The manifestation of verbal language depends upon a cerebral organ, and this cerebral organ lies on the posterior part of the superior orbital plate." By

numerous quotations it is shown, that the phrenologists of the first half of the present century were far in advance of the physiologists in their ideas of the locality of a part of the brain concerned with language. The phrenologists were also more correct in their views about sleep than many scientific writers of their time. In proof of this, it is mentioned that Dr. Caldwell records the case of a girl, in whom the brain, owing to loss of some of the bone of the skull, could be seen to protrude during activity, and to recede during sleep.

This paper by Dr. Wilks is so full of interesting discussions and references, that the reader must go to the original, as it is impossible to abstract it properly.

8. In this case the cervical enlargement of the cord was flattened on the right side; a cavity occupied the right cervical anterior cornu for its whole length: there was a smaller but similar cavity on the left side in the lumbar region; the cavities contained a rough shaggy material of a reddish-brown colour. The borders of the cavity showed marked degeneration of the nervous tissue. There was considerable hyperæmia, and several extravasations of blood were present.

9. In this paper a very good account is given of the best methods of obtaining reflexes, and also the diseases of the nervous system are classified according as to whether the reflexes are unaltered, absent, or exaggerated. The author performed some original experiments for the purpose of showing that the myotatic contractions were due to the loss of tone in the muscles, and some impairment of the reflex loop. A frog's muscle was removed from the body, but could not be made to contract by pulling on its tendon, although it responded to mechanical irritation directly applied to the fibres; but if the nervous system was uninterfered with, the muscle being left in the body, it was easy to get myotatic contraction by pulling on the tendon. It is concluded that the reason why the first experiment failed was because of the loss of tone, because the author thinks the time experiments that have been performed are conclusive proof that myotatic contractions are not reflex. The theories for the increased production of myotatic contractions in lateral sclerosis are discussed. Directions are given for obtaining the various clonuses and the front tap contraction.

An experiment is described which showed that the fifth nerve

has in it no fibres which cause dilatation of the pupil on strongly stimulating a sensory nerve, but that this result is brought about by the third nerve, probably through inhibiting the tonic influence, kept up reflexly by this nerve upon the circular fibres of the iris. The oscillations of the pupil are about twice as many for far as for near distances; this oscillation is absent in locomotor ataxy. Exhaustive or extreme pain causes dilatation of the pupils. Thus they are dilated after an epileptic fit, or after having a tooth extracted. These facts are useful in diagnosing malingering.

10. A boy, æt. 6½, ran away from school, but was shortly afterwards found lying in the snow, and when picked up, could not stand, having right hemiplegia. After this attack he seemed stupid, never spoke or read anything, and has always suffered from loss of control over the bladder and rectum. This case is too long to condense satisfactorily. The patient had various nervous symptoms, such as paralysis of various parts of his body, loss of intellect, &c.; but the chief interest lay in the extraordinary hyperpyrexia, which at first was not constant, but towards death gradually became more so. It was very persistent; cold baths had to be very frequent to keep it under; the highest temperature reached was 107°. At the post-mortem examination, the brain and cord were the only parts affected. There the only abnormality was a small soft patch, a quarter of an inch in diameter, at the anterior part of each corpus striatum. There was well-marked degeneration on both sides down the crura into the cord, taking the usual course; the inflammation had at some places spread into the anterior cornua. The question is discussed whether the change in the lateral columns is primary; but the author concludes that the change in the anterior cornua is secondary. The hyperpyrexia is discussed in his paper on the "Heat-centre Theory," in the succeeding volume of the Reports.

11. Dr. Wilks points out, that whilst hemiplegia produced by disease of the corpus striatum is not a paralysis of half the body, but only of parts of it, hemianæsthesia produced by a lesion of the sensory fibres would in most cases be not only a complete loss of sensation of the entire half of the body, but of the special senses also; but hemianæsthesia accompanying hemiplegia is rare and exceptional; whenever loss of sensation exists with hemiplegia, the lesion will be found to affect the back part of the internal capsule. Complete hemianæsthesia, such as is above mentioned as theoretically

possible, is unknown to Dr. Wilks. All the complete cases of complete hemianæsthesia that he has seen are functional, and get well. Bearing in mind the dual action of the brain, it is possible that the hemianæsthesia is due to the cessation of sensory function of one half of the brain, and the cases which follow on a blow may be due to some concussion affecting half the brain only. Many facts and arguments are brought forward to prove these two points. Cases are given to show, that on rare occasions, male patients may present the same symptoms of this nature as female.

12. A girl, æt. 2, admitted for right hemiplegia, left facial paralysis, double optic neuritis, nystagmus, unequal pupils and vomiting. On admission, the case was thought to be one of tubercular meningitis; but as the child lingered on in an almost moribund condition, the diagnosis of cerebral tumour was made. The child died about seven months after admission. At the post-mortem examination, in addition to the extraordinary emaciation, so great, that the superficial cervical plexus could be observed under the skin, there was observed extensive softening of the middle part of the right cerebral hemisphere; no cause whatever could be found for it. There was well-marked descending sclerosis of the crossed pyramidal tract in the cervical region on the left side: most of the organs of the body were tuberculous; but there was no evidence of tubercular meningitis, and although the right middle cerebral artery was small, there was no evidence that the softening was due to this, for it did not correspond to the distribution of the artery.

13. The resemblance between the cerebral symptoms of lead-poisoning, of alcoholism, and of paralysis, is pointed out. Also the importance of not confusing the diagnosis, because the treatment is different, although it is extremely probable that plumbism will give rise to general paralysis. The similarity in the pathology of the three conditions is very marked, all being characterised by wasting cerebral changes; and in the case of lead and alcohol the analogy may be pushed still further, for both lead to persistent contraction and thickening of the vessels with arterial spasm. Therefore opium, digitalis, nitrite of amyl and nitro-glycerine will be of use.

14. The author points out that nervous non-inflammatory pyrexia is present in the following maladies:—1. Tumour of the cord, especially of the cervical region. 2. Tumours of the brain, especially of the pons. 3. Hæmorrhage of the brain, especially of the pons. 4. Embolism of certain cerebral arteries. 5. Ill-defined

degenerative changes in the brain. 6. Insular sclerosis. 7. Locomotor ataxy. 8. Obscure nervous cases that die without any change being found post-mortem. 9. Obscure nervous cases that get well, "Hysterical pyrexia." 10. Mental disease. 11. Injury to the spine. 12. Injury to the brain. Lowering of the temperature is present in—1. Tumours of the brain; 2. Cerebral hæmorrhage; 3. Degenerative changes in the brain; 4. Mental disease; 5. Injury to the spine. Cases are given illustrating all the above conditions. The author shows that all the cases may be explained, by supposing that there exists on the cerebral cortex, near the fissure of Rolando, a calorific centre which presides over the thermogenetic tissues of the opposite side of the body, restraining their activity. The fibres from the centre proceed down, by means of the corona radiata near the central ganglia, through the crura, pons medulla and cord, decussating in their course. In the cases of organic disease of the brain accompanied by non-inflammatory pyrexia, the lesion destroyed these fibres in some part of their course, thereby causing a rise of temperature, owing to the inhibitory action of the calorific centre being cut off. In the cases in which the temperature fell, it was due to the fact that the inhibitory fibres were stimulated. The physiological side of the question is fully discussed, and it is shown that the clinical facts agree with physiological experiments. Whether or not the calorific centre is a genuine calorific one, or whether it be a muscular vasomotor one, is not yet decided; probably the former is the true view. In the cases of hysterical hyperpyrexia the explanation most probably is that there exists functional disturbance of the calorific centre.

W. Hale White, M.D.

I. **On a Diagnostic test for Sciatica.**—De Beurmann (*Archives de Physiologie*, April 1884, p. 375). Place the patient in a recumbent position, keep the leg extended, and gradually flex the thigh on the pelvis. Pain is caused, and he resists the movement.

Flex the thigh in the same way, but with the leg flexed. No pain is caused, and no existence is encountered.

The pain is caused, according to the author, by the tension put on the sciatic nerve, which, as he shows by experiment on the dead body, is greater in the first manipulation than in the second. He thinks the manipulation described furnishes a diagnostic sign of pain due to inflammation of the nerve as opposed to pain from disease of the joint or of neighbouring structures, and that it

furnishes a hint for treatment, viz. that we should fix the limb in the position in which the nerve is most relaxed. [The process known as "subcutaneous nerve-stretching," is based upon the facts adduced as new by this author. The thigh is flexed on the abdomen, and then the leg straightened out, thus placing the sciatic nerve on the stretch.]

II. **On the Changes in the Nervous System after Amputation.**—HAYEM and GILBERT (*Archives de Physiologie*, May 1884, p. 430). Amputation of right forearm just below the elbow in 1876.

Death from phthisis in 1883, at the age of 47.

Brain healthy and symmetrical.

There were neuromata on the ulnar medium and radial nerves at their terminations in the stump. These were composed of a large number of small nerve fibres, formed of an axis-cylinder covered with a thin layer of myeline, and grouped in fasciculi. The course of these fibres was very intricate, but for the most part their direction was the same as that of the fibres of the main nerve-trunk, till they approached the periphery of the neuroma; then they turned back in a looped fashion. Their relation to the healthy fibres of the nerve trunk seemed to be this:—that at different levels the healthy fibres perished and were each replaced by a number of thin small nerve-fibres, the actual point of continuity between the two kinds of fibres was, however, never observed.

The neuromata therefore appear to be the expression of a regenerative process; viz. the growth of new nerve-fibres from the cut-end of the nerve.

Changes were found in the nerve-trunks as follows: — The radial was slightly thinner than the nerve of the opposite side; the median, about the same size; the ulnar, considerably larger. All three were grey, rounded, and firm.

In the radial and median there was atrophy of nerve-fibres with growth of interstitial connective tissue. In the ulnar, two varieties of nerve-fibres were found. (1) Large isolated fibres, with a fine axis-cylinder and thick coating of myeline, accompanied by a longitudinal band of connective tissue; (2) fasciculi of small fibres with a comparatively large axis-cylinder, and thin coating of myeline. The interstitial elements of the nerve-trunks (neurilemma, perineurium, epineurium, &c.) were increased.

In addition, therefore, to the degenerative process found in the

other nerves, there were in the ulnar separative changes, analogous to those in the neuromata, indicated by the presence of the small fibres.

The anterior and posterior roots of the brachial plexus were atrophied, many of the normal fibres had disappeared, and there were more small fibres than normal.

Spinal cord.—In the *white* substance, the posterior columns of the affected side were smaller than those of the sound side; but for the other columns just the reverse relation held. Of the *grey* substance there was atrophy at the level of the brachial plexus (particularly at the level of the 7th and 8th cervical and 1st dorsal nerves), affecting chiefly the anterior horns, and principally due to atrophy of the cells; the number of which was in some places only one-fourth or one-fifth the number of those on the sound side. Careful search with high powers showed the relics of cells—small, regular in outline, but still presenting traces of their normal processes; even those that remained visible to a low power had undergone some modification; they were rounded, and had but few processes.

III. **On the Nervous System of an Idiot. Anomalies in the Convolutions. Arrested development of the Pyramidal Tract in the Cord.**—Hervouet (*Archives de Physiologie*, 1884, p. 165).

Age of patient 3½ years.

Atrophy of the frontal lobes, with thickening and adhesion of the meninges, superficial softening with more deeply seated induration of the convolutions.

On the left side of the brain (which was principally affected), all three horizontal frontal convolutions were atrophied, the superior in the highest degree; the ascending convolutions were poorly developed, the paracentral lobule was small. On the right side the changes were less marked.

In the spinal cord were the following abnormalities:—

In either lateral column was an area coloured brightly by carmine, and characterised by absence or paucity of nerve-fibres; this area corresponded roughly to that of the crossed pyramidal tract, but differed from it in shape (it had not the usual triangular shape), and in its greater extension in a forward and backward direction. There was, besides, atrophy (or non-development) of the columns of Goll, and of the right direct pyramidal tract.

During life there had been no spastic symptoms. From this fact, from the unusual area of the tract of lateral disease, from

the simultaneous disease of the columns of Goll (without focal lesion to have originated ascending degeneration), the author concludes that the disease of the lateral columns was not secondary to the disease of the brain, but was due to arrested development of the cord.

This is borne out by his investigations into the development of the healthy cord; for he finds that even in healthy children an area of the lateral columns corresponding to that observed in the present case, does not reach perfection till the age of 4 years. But, though the question is only one of degree, yet in no healthy child of $3\frac{1}{2}$ is the development so backward as in this idiot.

IV. On Radial Paralysis. Theory of Nerve-compression. JOFFROY (*Archives de Physiologie*, May 1884, p. 478).

The author seeks to establish the truth of Panas' theory of paralysis of the radial from compression, in cases where, at first sight, its applicability might be questioned.

The case he gives is that of a man in whom paralysis of the left radial came on suddenly, after carrying a weight of about 50 kilograms, strapped on like a knapsack. The weather was warm, he had experienced no chill, his previous health had been good. But in order better to support his burden he had been proceeding with his forearms crossed and the right hand clutching the lower end of the left humerus. In this way he had, says the author, compressed the left radial at the point where it comes out between the triceps and the supinator longus. He explains in a similar way a case narrated by Duchenne, where a woman went to sleep in a chair with her arms folded in front of her.

The radial nerve itself is superficial, and can be compressed against the bone at the lower part of the humerus; but it gives off a branch to the triceps, which is partly covered by muscular fibres; consequently where this branch is compressed too, the triceps is also paralysed, though this is rare, and the paralysis is slight in degree, because this branch is partly protected from pressure by the covering of muscle.

On a Case of Transverse Myelitis. RAYMOND and ARTAUD (*Archives de Physiologie*, January 1884, p. 114).

Male patient, age 47. Very doubtful history of syphilis. In August 1882 left leg began to drag; some days later, sudden but transient failure of power in both legs while walking; then increased loss of power in left leg. Next, loss of power in con-

trolling evacuations, and incomplete paraplegia. The whole came on within a few weeks. Antisyphilitic treatment by MM. Charcot and Lasègue produced no benefit. Within six weeks he was admitted to the Hospital for Incurables, under the author. There was then complete paraplegia of the flaccid type, with anæsthesia to all forms of sensation, with abolition of tendon reflexes, and partial preservation of skin-reflexes; crossed reflex on tickling the feet. Farado-contractility in thigh-muscles feeble, in muscles of legs almost absent. Bedsores on heels, inner aspect of knees, and sacrum. Death from pyæmia six months later.

Post-mortem.—No lesion of vertebral column or meninges. *Spinal cord.*—In *mid-dorsal* region transverse myelitis, leaving unaffected only a few fibres round the anterior cornua and between the posterior cornua. All the constituent parts of the cord were (with these exceptions) involved indiscriminately at this level.

Above and below the mid-dorsal region the *grey matter* recovered its normal appearance; but in the white matter there was—*above* the lesion, degeneration of the columns of Goll reaching to the upper part of the cord; of Burdach's columns, ceasing rapidly as the sections passed up the cord; of the cerebellar tracts, to the upper part of the cord; *below* the lesion, degeneration of the crossed pyramidal tracts reaching to the lumbar region.

The adductor muscles of the thighs were in a state of degenerative atrophy. The spinal ganglia and sciatic nerves were normal.

The authors think that the lesion was not syphilitic, as there were no other syphilitic lesions, and anti-syphilitic treatment did no good. The myelitis is best classed as a sub-acute myelitis. The acute decubitus is to be connected with the extensive transverse lesion of the cord. There were no symptoms pertaining to the upper limbs.

VI. Hemiatrophy of the Tongue in Tabes Dorsalis.

BALLET (*Archives de Neurologie*, vol. vii. (1884), p. 191).

Atrophy of muscle, irregularly distributed and not regularly progressive, occasionally complicates tabes. Hemiatrophy of the tongue has been noticed by Charcot (and also by Ross and Erb) as an early symptom of tabes.

In addition to a case by Cuffer (for which see next Abstract) the author mentions three cases.

1 (under Vidal). Male, age 17 at time of onset. The affection began in 1863 with sudden numbness of the left arm. Afterwards paralysis of the left side of face and left auditory nerve (sudden

onset), of the left 6th nerve; and difficulty of speech and swallowing. In 1866 pains in the limbs and arthropathy of the left shoulder. When the observations were made in 1875 there was—atrophy of the left half of the tongue (the taste and tactile sensibility remaining normal), paralysis of the left auditory nerve; wasting, with absence of farado-contractility in the left shoulder-muscles; arthropathy of the left elbow-joint, and to a less degree of the left shoulder.

2. Female patient at the Salpêtrière, age 51. In addition to the usual symptoms of tabes (the diagnosis of tabes was confirmed post-mortem), there was—arthropathy of both knees and of the right shoulder, paralysis of the internal and external recti of both eyes, atrophy of the left half of the tongue.

3. Male, age 35, still under observation. Besides the ordinary symptoms of tabes there was—atrophy of the muscles of the hands, and to a certain extent of the arms and of the sacro-lumbalis; paræsthesiæ in the district of the right fifth nerve; atrophy of the right half of the tongue. The affection of the tongue gave rise to very little trouble in mastication, swallowing, or speaking.

Hemiatrophy of the tongue is rare (the author says) in every form of disease except tabes (putting aside injuries to one hypoglossal), but pretty frequent in tabes; it should therefore lead us, when it is present, to suspect the presence of tabes. He ascribes the symptom to lesion of the hypoglossal nucleus, and notes the association with it (α) of ocular paralysis; (β) of atrophy of muscles in the limbs and trunk. He thinks that in these cases the sclerosis in the cord spreads from the posterior columns to the anterior cornua, viâ the commissural fibres described by Gerlach and Kolliker. In the medulla, the sclerosis spreads by a similar path (not yet anatomically demonstrated) from the root of the trigeminus to the motor nuclei of the medulla. From this point of view he emphasizes the existence (in his last case) of paræsthesiæ in the district of the right trigeminus; and he thinks that nervous disturbances in this area would be found in all cases of tabetic hemiatrophy of the tongue, if carefully looked for.

VII. **Hemiatrophy of the Tongue in Tabes Dorsalis.** RAYMOND and ARTAUD (*Archives de Physiologie*, 1885, April 1, p. 367).

The case was originally described by Cuffer in 1875. Tabes had then existed for eight years; though for four years the symptoms had been limited to girdle-pains. There had been difficulty of

speech and of moving the tongue for a year. Slight atrophy of the right thenar eminence was made out, and well-marked atrophy of the right half of the tongue, with fibrillary contractions.

When seen again by Raymond in 1883, the most striking symptoms were as follows:—

General emaciation (though the farado-contractility of the muscles seems to have been preserved). Atrophy of the right half of the tongue. Deglutition normal. Speech comprehensible, though the articulation of some words was bad. No other bulbar symptoms, except immobility of the pupils.

Post-mortem.—There was sclerosis of the posterior columns, most extensive in the dorsal region, where it involved the posterior cornua and extended even to the anterior cornua, the cells of which were atrophied. In the cervical region the antero-internal group of motor cells, especially on the right side, was atrophied.

In the medulla, the principal nucleus of the hypoglossal, on the right side only, was atrophied. The accessory nucleus of the hypoglossal (= antero-lateral nucleus of Clarke, reticular formation of Stilling) was normal on both sides. The motor nuclei of the mixed nerves about the same level (vagus, glossopharyngeal, spinal accessory) were slightly affected, and less on the left side than on the right. All the other nuclei were normal.

In the right half of the tongue, the muscular fibres were much reduced in number, and fatty tissue had taken their place. In the trunk of the right hypoglossal many fibres were normal, but in others there was segmentation of the myeline, with disappearance of the axis-cylinders.

J. A. Ormerod, M.D.